AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

FEBRUARY, 1897.

CONTENTS.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

VIII.

(*Continued from page 4.*)

STORE-HOUSE.

This occupies one end of a building, in the other end of which the offices are located. It is centrally located and accessible from any part of the works. Everything in the store-house is kept in admirable order and a very complete system has been devised for keeping account of the materials received and given out.

The store-room is two stories and the whole inside available space is provided with bins and shelving. A large open space is left in the upper floor, which allows the lower floor to be well lighted. A small wooden crane is provided on the upper floor by which any heavy articles can be conveniently raised to the upper floor. Each shelf or bin is numbered and has a card, which is kept in a tin slide attached to the top of the bin, on which all material received and all given out is entered. None is given out, excepting on orders from the different departments, and after these are filled the order goes to the office and the material is charged to its proper account. The card makes it possible to determine at any time the amount of material which should be on hand in the bin. The store-room is divided into sections, which are devoted to certain classes of material.

PAINT SHOPS.

The painting of freight cars is done in a pair of wooden buildings containing six tracks, each of which will hold from eight to nine cars. There is not much to be said of this building or the work done in it excepting that it is liable to burn up some time.

The paint shop for passenger cars is, however, a model in its way. It is a brick building with a cement floor, and is 420 by 135 feet, and divided into four sections by crosswalls. The building is admirably lighted with skylights and also with windows. The tracks are arranged transversely to the building, and the cars are handled and moved to and from the building by a transfer table, which is operated by electricity. The table is also provided with a capstan, also operated by electricity, with which the cars can be moved to or from the table. Inside of the building, posts are arranged alongside of the tracks, to which movable brackets can be attached and placed at different heights. These carry the planks or scaffolding, on which the men work while painting the cars and preparing them to receive the paint, and dispenses with the use of trestles. In washing cars and rubbing down the different coats of paint, a good deal of water is used. This always makes a paint shop a wet, sloppy and disagreeable place. To avoid this, the shop here described is provided with gutters alongside of the tracks. The distance apart of these gutters, measured between their centers, is equal to the width of a car-body. They are depressed below the surface of the floor, and are connected with the drains, and are covered with iron gratings, and the cement floor slopes toward the gutter. With this arrangement the water used in washing the sides of the cars runs down directly through the gratings and into the gutters and thence to the drains, and any water on the floor also runs into them. The floor is thus always kept free from water.

The shop is lighted with both arc and incandescent electric lights. The latter are attached to long insulated wires connected to the feed wires at the roof. They are then carried down from R and around a pulley P, Fig. 1, attached to a counterweight W and up over another pulley p fastened to the roof, and then downward to the lamp L, which is suspended at this end of the wire. The counter-weight is just heavy enough to balance the lamp, and therefore if the latter is raised or lowered it will stay in any position, or it can be carried into the inside or under the car or any other desired position. The lamps are all protected by wire guards. Suitable iron sinks are placed in convenient positions and are supplied with cold water and steam with which the water can be heated to any desired temperature.

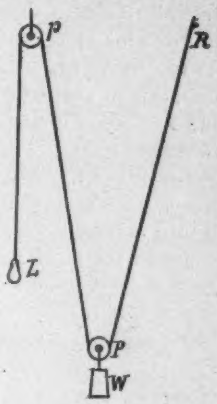


Fig. 1.

The water closets are better than many which are found in hotels, and are kept scrupulously clean, a convenience which is provided for comparatively few workingmen.

One of the sections of the shop is used for a varnish room for sashes, blinds, etc., and is provided with racks, etc., which are required in doing this kind of work.

The whole building is heated and ventilated by Sturtevant's apparatus. Two large fans, about 6 feet in diameter, are provided, which are driven by two 25 horse-power engines. The machinery for heating, ventilating and lighting is located in a building detached from the main shop. The air is drawn by the blowers through a system of steam pipes and is then forced through larger pipes and distributed in different parts of the shop. The drying of paint and varnish is dependent very much on the ventilation of the place where it is exposed. A given amount of air will absorb a certain amount of the volatile portions of paint or varnish, and unless the air is then changed the process of drying will cease or be much retarded. The apparatus here described furnishes a constant supply of fresh, warmed air which escapes from the building through every available crevice and opening, and there goes with it the volatile elements of the paint, which it has absorbed, and the fresh air which enters the room takes up more of the same substance, which is in turn carried away by the escaping air.

The engine-room is equipped with two 50 horse-power Westinghouse engines, two are light dynamos, one incandescent dynamo and one generator to furnish electricity to the transfer table.

The materials used in the paint shop are stored in a building adjoining it.

BOLT SHOP.

A separate building is devoted to the manufacture of bolts and

to cutting the threads on them. This is equipped with a very complete plant of heating furnaces, bolt-making and cutting machines. Both in the bolt and the paint shop nearly all the work is done by piece-work, and those in charge of it give the same reports which were received from all the other shops, that is, that the output of work is greatly increased, and the cost very much reduced thereby, and that it is very popular with the men, who earn higher wages when working by that system than they do when employed by the day.

Another result is that there are no trades unions in Altoona. The men employed there seem to have their social desires satisfied by the church and lodge meetings, and their business enterprise seems to have an outlet through the various building associations which have been organized there.

SCRAP YARD.

The scrap piles of a railroad shop are always interesting and profitable places for observation and study. They are the receptacles of the failures which occur, and the causes of these may be observed here better than anywhere else. This is especially the case where their contents are assorted and classified. A pile of broken couplers will reveal their weak places more effectively than any amount of theorizing or the most abstruse calculation possibly could. The Pennsylvania Railroad have established a technical school of this kind, or what might perhaps be called a mechanical school, which is known as their Scrap Metal Yard, to which all the condemned material from the whole line, east of Pittsburgh, is carried; which suggests that a course in scrap study might be a profitable one in some of the regular technical schools. A professorship of scrapics is suggested.

The object in establishing this yard was to utilize all the condemned material to the best advantage. This is done by assorting it into various kinds, which makes it more salable and it thus commands a higher price. The material when it arrives in this yard is cut to pieces or is separated into its constituent parts, so that it can readily be assorted. The parts which are capable of being used over again are then separated from that fit only for scrap to be reworked. The following is a partial list of the kinds of things which are found in lots of condemned material, but which are often good enough for further service: Bolts and nuts, washers of all kinds, springs, spring-seats, draw-heads, automatic couplers, journal-boxes, center-plates, dead-blocks, brake-wheels, brake-shafts, brake-shoes, brake-beams and hangers, arch-bars, truck-columns, channel-bars, truck-trussrods, draft-castings, stake-pockets, pocket-staples, shafts for drop-bottem cars, corner-bands, steps, brace-pockets, bolster-irons, channel-bars for transoms. Many of these, when taken from condemned or wrecked cars are good for further service. Some of the old timbers taken from cars are used for sleepers in sidetracks of yards, etc., and the old lumber is cut up and used for kindling and firing stationary boilers.

The scrap which cannot be used over again is assorted into the following classes—wrought-iron clippings and punchings, flues and pipes, steel turnings, screw-cuttings, malleable casting scrap, stove and grate scrap, boiler steel, steel axles, iron axles, miscellaneous steel, light smith scrap, selected smith scrap, light cast scrap and wrought-iron turnings. Besides these classes some miscellaneous material such as old barrels, rope, zinc, etc., comes to the yard, all of which is disposed in some way. The amount of the material received which can be used over again is estimated to be about 10 per cent. of the whole. Of course, much of it is in a more or less damaged condition and is bent or otherwise injured, and requires renewal or repair. To do this the yard is provided with a small shop equipped with an engine and boiler, two blacksmith's forges, one power hammer, a big power shears, two bolt cutters, two air pumps for supplying compressed air to an axle tester, * which is located in the iron yard, and to a new air hoist which bas just been put up for loading and unloading cars. In this shop all kinds of repairs and renovation is done on the material which is fit for re-use. Bolts are straightened and recut, or, if the thread is spoiled the ends are cut off and shorter bolts are made of what is left. Rods and bar-iron are sheared into lengths suitable for making new bolts; pieces of iron are straightened or otherwise put into condition to fit them for re-use.

A new air hoist of a very excellent design was just being erected at the time the yard was visited. It was of the gallows frame form and extended over several tracks. It is supported on tripodal posts, each made of three steel rails, which are spread apart farther at the base than at the top. The transverse beam is formed of two channel-bars trussed with two sets of truss-rods. A vertical air cylinder is carried by a trolley, which runs on the channel-bars. These and the trusses are placed far enough apart so that the air cylinder can be hoisted up between them.

From ten to twelve hundred tons of scrap are received at this yard every month. It is estimated that of this about 150,000 pounds of wrought iron is used over again, and 75,000 pounds of cast iron. Wrought scrap is worth about ½c. per pound, and new forgings 2¼. Cast scrap is worth perhaps ½, and new castings 1½c. The difference between these prices is what the company makes by re-using the material, which amounts to $2,625 per month, or $31,500 per year, from which, of course, the labor and cost of repair and handling must be deducted. It is not possible to ascertain the profit to the company without knowing accurately the expenses which are incurred in accomplishing the results which have been described. Complete accounts and some systematic book-keeping is required to ascertain how much this department is paying.

THE JUNIATA SHOPS.

It was explained in the first of this series of articles that the Juniata shops, which are located about a mile and a half east of the locomotive repair shops, were primarily intended for the construction of new locomotives. They were designed by Mr. Ely and his assistants during his administration as General Superintendent of Motive Power in Altoona, and it was their aim to have the whole equipment and all the appliances of the latest design and of the most approved and improved kind. They were located on vacant ground with hardly any limitation of space or locality of shops, excepting that the ground had to be graded to conform to the height of the railroad on one side and a street on the other. Before the shops were commenced the most modern plant and appliances for building locomotives in this country and Europe had been carefully studied, and it was the purpose of all concerned to make of the establishment at Juniata a model one.

The arrangement and location of the shops is shown by the plan, which was printed in our June, 1896, number. They are on the north side of the main line of the railroad, the dotted line below the plan representing the dividing line between the grounds occupied by the shops and the main line of the road. The dotted line above, at the top of the plan, is the boundary between the grounds and a street, on which is an electric railroad, by which these shops may be conveniently reached. The entrance-gate and lodge for gatekeeper is indicated just above the office and storehouse, on the boundary line. The approach to the office and shops was originally low ground, but has been filled in and sodded, and laid off with graveled walk and geometrical plots. Inside the gate is a large circular plot bisected by a walk and with a flagstaff in the center. The words, "Juniata Shops" are laid off in large letters on the plot with plants growing in the letters.

The office is a very neat brick building, with a wide arched entrance, and, like all the other buildings, the exterior is perfectly plain, but designed with admirable taste. Its general appearance is shown in the view of these shops published in our June number, page 90, from which it may be seen that it is two stories high and that the rooms are all admirably lighted with large mullioned windows. The office for the clerical force is in the west end of the first floor, and that of the Master Mechanic, Mr. Thos. R. Browne, is back of it. The drawing-room is over these offices. The eastern portion of the first and second floors and basement are occupied by the storekeeper's department. A hand elevator extends from the basement to the second story. The interior is shelved all around and most of the shelving is

* Illustrated in the *American Engineer* of April, 1896.

divided into bins, of which there are about 3,500 in all, which will give some idea of the variety of the material which must be handled and provided for.

BOILER-HOUSE.

The boiler-house is provided with six cylindrical boilers, 75 inches in diameter and 18 feet long, with 94 4-inch flues. The boilers are all provided with Roney mechanical stokers and furnaces.

The furnaces are built back of the end of the boiler, speaking in locomotive parlance, and are lined with fire-brick. The grates are inclined and are operated by machinery, the firing and feeding of coal and the removal of ashes are all done automatically. The grates are divided into two parts longitudinally to the boilers, and the central portions are elevated for the purpose of equalizing the combustion over their whole surface. The stokers are operated by a 5-horse-power Westinghouse engine, and the conveyors for coal and ashes by another 15 horse-power engine of the same make. Experience with this device has shown that it is economical both in fuel and labor.

The boiler-house, being a detached building, is lighted from all sides, and as the coal and ashes is all handled by machinery, the boiler-room is as clean as any first-class machine-shop, and what with perfect ventilation and lighting it is in marked contrast—so far as the comfort of its occupants is concerned—with some of the black holes used as boiler-rooms which are often encountered, and in which men are compelled to work.

The chimney for these boilers is a work of boilermakers' art. It was shown in the general view of the shops, published in our issue of April, 1896, but the engraving is on so small a scale that it does not do justice to the structure. It is of a beautiful graceful outline, the base, which is not shown in the engraving, being curved out so as to be about double the diameter of the chimney, a short distance above it. The height is 124 feet 6 inches, and its diameter at the top is 8 feet. It is lined with fire-brick below for about one-third of its height, and with ordinary red brick above that, all of which rests on a masonry foundation capped with cut stone.

ELECTRIC AND HYDRAULIC BUILDING.

This is just west of the boiler house and is equipped with two Westinghouse 85 horse-power compound and two of 45 horse-power engines. Just south of the Juniata shops the eastbound classification yard is located. This has a large number of tracks, on which eastbound freight cars are classified according to their destination. The tracks have a descent eastward, and the switching or "marshaling" of the cars is done by gravity, the switches being operated by pneumatic power. The compressed air for doing this work is supplied from the building, which is here described, by two Norwalk air compressors, one of which has a steam cylinder 14 by 20 inches, and the other a cylinder 10 by 12 inches. These compressors also supply air for operating hoists and pneumatic machinery of various kinds with which the shops are liberally furnished. A pumping engine by the Dunkirk Engine Company, with a capacity of 100 gallons per minute, supplies water under pressure for operating various kinds of hydraulic machinery in the shops. The water is forced into two accumulators with 14-inch plungers, having 10-feet stroke. A Barr pump, with a capacity of 3,000,000 gallons per day, supplies water to the whole establishment.

The electric machinery consists of one 500-volt U. S. Electric Company's generator, two dynamos by the same company, and one alternating current Westinghouse dynamo for arc lighting. The dynamos are driven by the Westinghouse engines already described, the power being transmitted by Evans' friction pulley. The engine has a large pulley on its shaft and the dynamo has a small one, which is encircled by a number of narrow loose belts, the aggregate width of which is equal to that of the pulleys. The dynamo is arranged so that the pulleys can be brought in contact, the belts acting as a sort of transmitting material between the two pulleys. There are also two incandescent dynamos operated in the same way.

All the exhaust steam from the engines and pumps is carried back to the boiler room by means of a "steam loop," furnished by Westinghouse, Church, Kerr & Company, of New York. A Webster vacuum exhaust steam economizer in the boiler room also helps to reduce the consumption of fuel. This was made by Messrs. Warren, Webster & Company, of Philadelphia.

SMITH SHOP.

This was the next building visited. Near the western entrance a very heavy hydraulic scrap shear, built by the Walker Manufacturing Company, of Cleveland, is located for cutting up scrap to be reworked in the smith shop. This will cut a cold bar of 12 square inches area.

The bolt department is located at the western end of the shops and is brought to the notice of a visitor in entering. The iron is first sheared to the proper lengths on two shears, Nos. 1 and 4, built by the Hillis & Jones Company, of Wilmington, Del. It is then heated in oil heating furnaces illustrated herewith, which were designed by Mr. Browne, the Master Mechanic of these shops.

The various sizes of bolts are headed on one 2½-inch header by the Forsyth Machinery Company, of Manchester, N. H., a 1½ and a 1¼-inch header, by the National Machinery Company, of Tiffin, O., and a 30-ton hydraulic header designed by Mr. Browne and built in the shops. The other equipment consists of one 600 and one 800-pound Merritt Bros. drop hammer, a No. 8 trimming press by the same makers, one Sellers and one Bement 6,000-pound steam hammer. These are used in connection with three regenerative heating furnaces, with 5 by 7-foot beds and one with a 3¼ by 4½-foot bed. Besides these large hammers there is one 3,000-pound, two 1,600-pound, four 1,100-pound, and one special frame 1,600-pound hammer built by the Morgan Engineering Company.

The shop is equipped with 24 double forges, each of which has its smoke pipes connected with large horizontal pipes near the roof, which are provided with suction fans run by 5 horse-power electric motors. This draws out the smoke and keeps the shop free from gas and dirt and makes it a fit place for human beings to work in, which cannot be said of some blacksmith's shops which could be named. All the hammers are connected by a steam loop with the boiler-room and the condensed water is thus returned to the boilers.

All bolts and small work in this shop are handled in iron boxes made especially for the purpose, and which it is found facilitates the handling very much. This shop, like all the others at Juniata, is a model in the matter of lighting. The roof is high and the windows large and carried up as near to the roof as was practicable. The proportion of wall area which is glass is much greater than in most shops, especially the older ones. That special form of stupidity which does not recognize the importance of admitting all the light possible into workshops, is very common, but can usually be laid on the shoulders and consciences of architects and civil engineers who design the buildings. It may safely be asserted that if sunshine is excluded, too much light cannot be admitted to a workshop. The time is probably coming when every workshop will be sort of crystal palace with works of art on the walls, and a conservatory in every window. Already landscape gardening and that infallible indication of superior civilization—decent W. C.'s—are now very common.

BROWNE'S HEATING FURNACES.

A very neat and effective form of oil-burning heating furnace, designed by Mr. T. R. Browne, the Master Mechanic, is in use in the blacksmith shops for heating iron up to 3 and 3¼ inches diameter. The fuel used is "reduced" mineral oil, or oil from which the kerosene for lighting purposes and the most volatile constituents have been extracted, and which is consequently less liable to ignition or explosion than crude oil is.

As a preliminary to an explanation of the furnace, referred to here, it may be said that for the combustion of the fuel which is used in this furnace various kinds of burners have been tried and are used. The degree of success which has been attained is indicated by the fact that while a pound of the fuel used contains about 21,000 units of heat, only about 11,000, or about half of it,

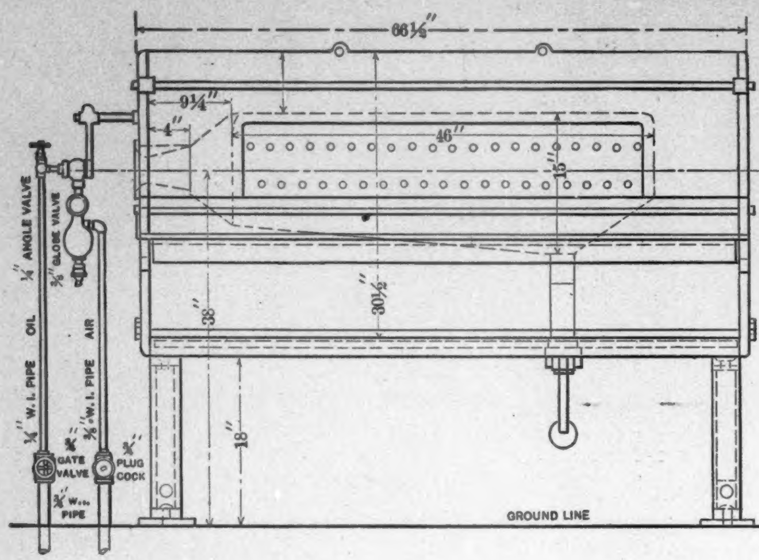


Fig. 2.

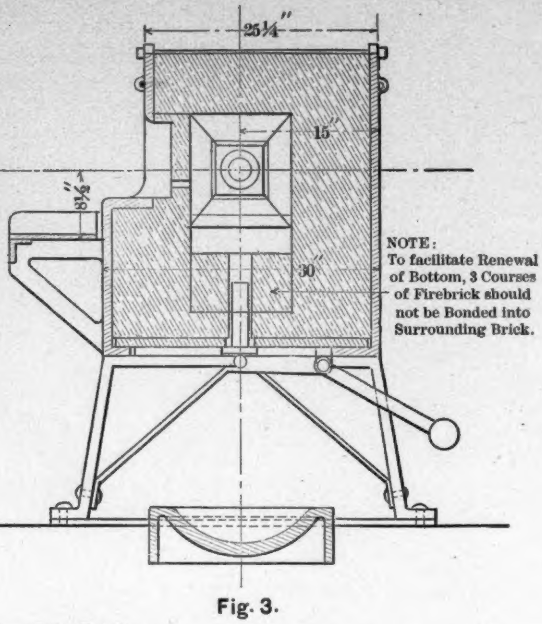


Fig. 3.

Browne's Heating Furnace for Oil Fuel.

is converted into useful work—that is about fifteen pounds of iron are heated per pound of oil, whereas in the furnaces used in the Juniata shops the heating of thirty pounds of iron to a weld-

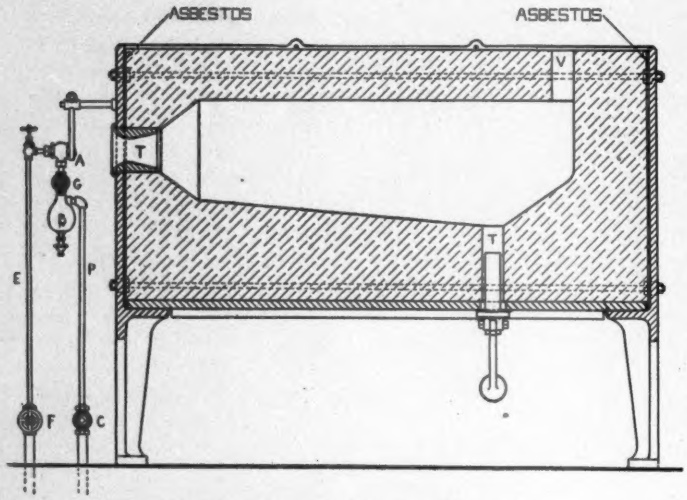


Fig. 4.—Browne's Heating Furnace.

ing heat, per pound of oil, is recorded almost daily, when the furnaces are running steadily.

The general form of the furnace is shown by the engravings Figs. 2, 3 and 4, which represent a side view, a transverse and a longitudinal section respectively. The combustion of the oil is effected by means of an apparatus, shown at the left hand end of Figs. 2 and 4, in which the oil is atomized and converted into a spray or mist by the action of compressed air. Fig. 5 is a sectional view of the atomizer on a larger scale than the other figures. The air is made to combine or commingle with the oil in a jet of a definite form, which flows into a combustion tube or generator *T* in the end of the furnace; the atomizer *A* being four or five inches away from the furnace; the jet which is shown by shading lines directed centrally toward the mouth of the tube *T*, into which the combined air and atomized oil are delivered. On starting up, the oil in this form is ignited inside of the furnace, and at the mouth of the tube, by a lighted bunch of oily waste, which is kept burning until the tube is heated. When this occurs the oil, which comes in contact with the hot tube in a finely divided condition, is converted into a gas at the inner end of the tube. At the same time, the velocity of the jet produces and carries with it into the tube an induced current of air, which supplies the oxygen required for the complete combustion of the oil.

The furnace consists of an external casing of cast iron, bolted together and lined first with asbestos about ¼ inch thick in the inside and then with fire-brick, the form of the interior being as shown in the sectional view. The front of the furnace has a series of fire-bricks with holes, shown in Fig. 2, of the required size and form, through which the iron to be heated is inserted. These holes are made very little larger than the iron so that a comparatively small portion of the products of combustion escapes through the holes around the pieces of iron which are to be heated. The result is that only that portion of the metal which projects into the furnace, and which must be worked, is heated. When the holes in the fire-brick become worn they are used for heating larger sizes of iron.

A vent, *V*, Fig. 4, is made in the top of the furnace for the

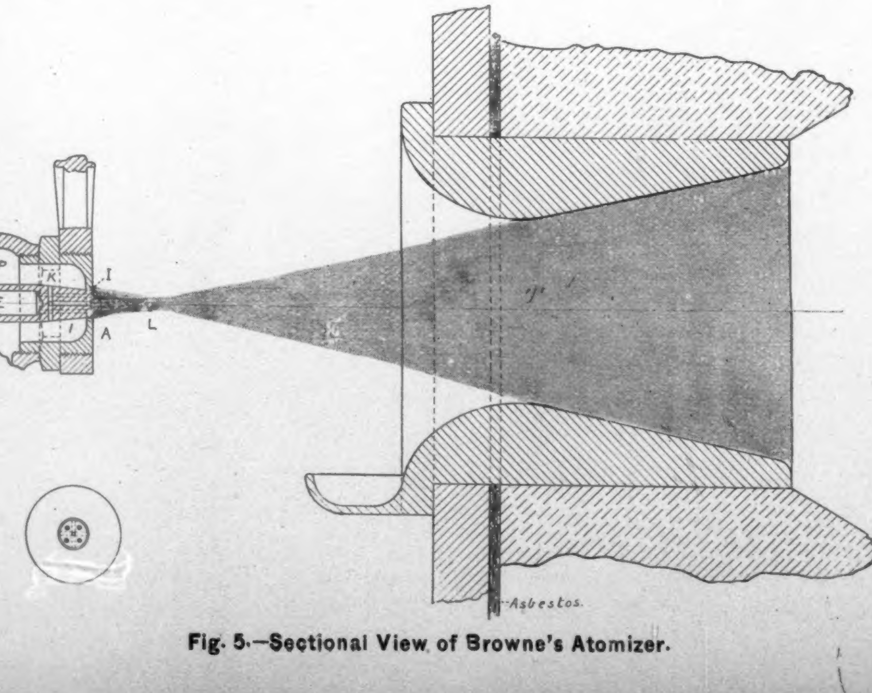
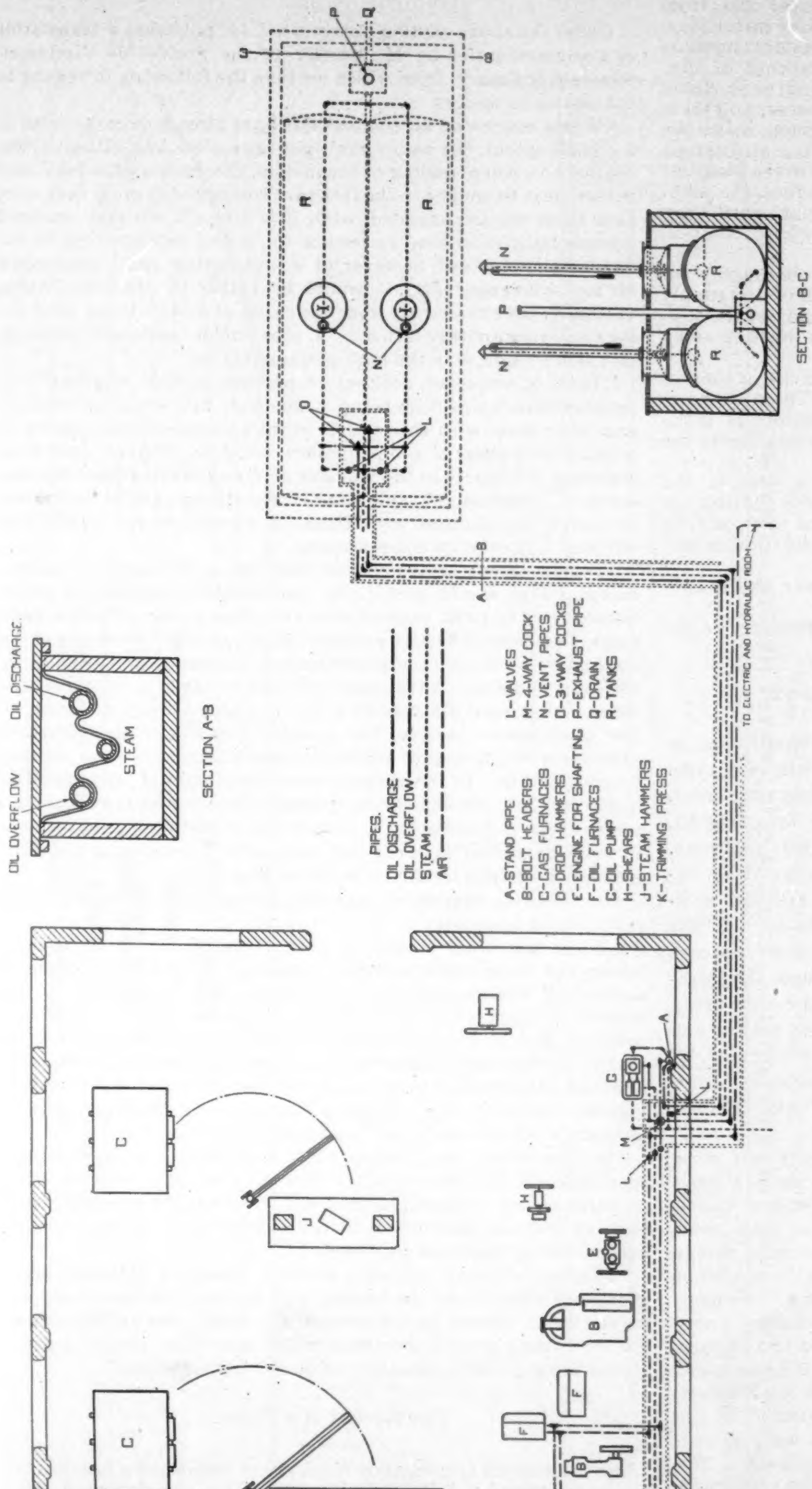


Fig. 5.—Sectional View of Browne's Atomizer.



LOCATION OF BROWNE'S HEATING FURNACES IN BLACKSMITH SHOP AT JUNIATA SHOPS.

escape of the products of combustion and a cinder tap, *T*, shown in Fig. 4, is provided in the bottom of the furnace by means of which the cinders may be drawn whenever they accumulate.

The construction of the atomizer and burner is shown by Fig. 5. Referring to Figs. 4 and 5, the compressed air is delivered to the apparatus by the pipe *P*, which has a plug cock *C*, shown in Fig. 4, at its lower end, by the adjustment of which the pressure of air in the atomizer may be regulated. The air flows first into a trap *B*, which collects any moisture or other impurities which the air may contain. It then passes through a globe-valve *G*, by which the supply is shut off or let on, and from which it enters the atomizer *A*. Oil is supplied by a pipe *E*, the amount of which is regulated by the valve *F*. The oil enters the atomizer through a strainer not shown in the engravings The nozzle, *E*, has four longitudinal holes drilled in it, which are shown by black circles in the lower left hand corner of Fig. 5, and by dotted lines in the view above it. The oil flows through these holes, and at the same time the compressed air enters the atomizer through the space *P*, around the nozzle, and escapes therefrom through the annular opening *I* around it and also through a central hole in it, which is connected to the space *P* inside of the atomizer by the transverse holes *K*. The oil, as it escapes from the nozzle, is thus inclosed in a what may be called a hollow cone of compressed air, which issues from the annular opening around the nozzle, and there is also a core of compressed air inside of the oil. The velocity of the currents of compressed air causes them to converge at *L*, which may be called the neck of the jet, after which the expansive force causes it to expand into a conical form as it flows into the combustion tube, and is shown by the shading. As indicated in Fig. 5, the currents of the two substances remain somewhat apart for a short distance after they are discharged from the nozzle, but their combination is complete after they expand fromthe contracted portion of the jet and when they enter the combustion tube.

The compressed air thus has the effect of dividing up the oil and carrying it with it in a uniform jet into the combustion tube, and, as it acts on the principle of the injector, it takes with it air sufficient for the complete combustion of the oil. As soon as the inner end of the combustion tube, *T*, becomes thoroughly heated, the inflowing jet brings the atomized oil or spray in contact with the heated metal, which at once converts the oil into a gas, and, being mixed with air, the combustion is instantaneous and complete at the inner end of the combustion tube. The constantly inflowing jet impels the burning gas to all parts of the furnace, and thus reaches all the material to be heated. The atomized oil, continuously supplied, provides for a uniform generation of gas,

thus giving with this type of furnace and atomizer all the advantages of the retort system for making producer gas from oil without the disadvantages of a separate expensive installation for the making of that gas, nor the danger attendant upon its manufacture and storage, and also without the expense of outward application of heat to the retorts. No residuum or products of combustion have ever been found in these furnaces, and there is, of course, owing to the completeness of combustion, no smoke or accumulation of gases in the shop. The inflowing air current from the shop, through the tube described, secures to the atomizer or burner ample protection from heat or flame; in fact, the jet of oil and air can be seen in their combined condition until they reach the inside end of the tube in the furnace, where combustion takes place.

The burners are made of very few parts, are thoroughly adjustable, having separate valves for the regulation of the supply of air and oil, enabling the operator or heater to adjust the supply of each, and so prevent excessive scale or the wasting away of the iron which is heated.

The oil and air are not allowed in any way to come in contact with each other, except outside of the burner. There is, therefore, no possibility of gas accumulation or explosion, as is the case with the crude oils when they are allowed to mix inside the burner and form an explosive mixture.

These furnaces have now been in use for over a year in the Juniata shops, and have worked very satisfactorily during all that time. The United States Fuel Oil Equipment Company, in the Bourse Building, Philadelphia, have taken up the furnace and may be communicated with at that address.

A patent has been applied for on this oil burner and is now pending in the patent office.

Fig. 6 is a plan showing the location of the furnaces in the shop in relation to the other plant.

American Passenger Coaches in England.

The South-Eastern Railway of England has recently put in service an entire train of passenger cars of the American type. There are two first-class cars, one second-class, three third-class, and one brake van. The cars are 51 feet 6 inches long over all, 7 feet 6 inches wide, and have Gould vestibuled platforms. They were built by the Gilbert Car Company of Troy, N. Y., except the brake van, which was constructed by the railroad company. The first-class cars seat 26 persons each, the second-class 27, and the third-class 38 passengers each. The first-class cars have revolving chairs, similar to our parlor cars, and the third-class cars have fixed seats, those on one side of the aisle being wide enough for two persons and those on the other seating one person only. The cars are neatly finished, and are lighted by electricity furnished by a motor driven from an axle. Commenting on the advent of this train the *Railway World* (London) says:

"When one comes to reflect upon it, there are really few more awkward situations than that of the traveler who finds himself one of five occupants of a seat on one side of a narrow box, facing five other occupants on the opposite seat, and with so little room to spare that the slightest relaxation of the perpendicular brings him into contact with his neighbors' persons. It is a kind of 'privacy' that may very comfortably be exchanged for a little more publicity, if accompanied by more elbow room. This change is now happily taking place, and for it we are largely indebted to American railway practice. In America the compartment system never found favor. In fact, the opinion that the traveler from the Western world has of our compartments system was well illustrated by the inquiry put to a guard at Charing Cross station by a waiting passenger as to when 'this collection of band-boxes' was to start. The 'band-boxes' are now undoubtedly on the decline. The Pullman carriages of the Midland and Great Northern Railways iniated the departure; but for many years they remained the only representatives of the long car in Britain. Eventually there came the Pullman trains on the Brighton Railway, and the Gilbert drawing-room cars of the South-Eastern. In more recent years corridor carriages and dining cars have become familiar on several routes, but it has remained for the South-Eastern, under the enterprising management of Mr. Alfred Willis, to give the public the first genuinely American train. The Brighton Company, it is true, instituted the Pullman train, but this is reserved for first-class passengers, while the train on the South-Eastern is designed for all classes. The new train differs, of course, very largely in detail from American models, but in the main features it is Transatlantic in conception and design. . . . To show how the public appreciate the increased comfort and how little it cares for the loss of 'privacy,' as enjoyed in the old compartment carriages, it may be mentioned that the new train is very largely patronized; in fact on several occasions it has left Charing Cross station with passengers standing in the aisles."

Compounding Compressed Air Motors and Reheating.

Under the above caption *Compressed Air* publishes a translation of a communication by M. Mortier to the Société de l'Industrie Minérale of France, from which we take the following in regard to compounding motors:

"While compound air compressors have already been adopted to a certain extent, the use of multiple expansion has hitherto been limited to a compounding of the motors, the reason of which limitation must be sought in the fact that compound engines cost more than those not compounded, while it is difficult, without warmed intermediate receivers, to restore its initial temperature to expanded air. Instead, however, of compounding each compressed air motor independently, it would be better to compound them mutually, the exhaust air from one series of motors being collected for supplying another series in a pipe under moderate pressure, laid side by side with the high-pressure mains.

"There is, moreover, nothing to prevent various lengths of this supplementary pipe from being connected, first with one another, and afterward with the receiver of the successive compressors, in which case a series of compoundings would be obtained, nothwithstanding differences in the volumes of air exhausted from the two series of motors, and in this manner something akin to the system of electric distribution with three conductors would be effected, without, however, its complication.

"Besides great saving in the first cost of the motors, a mutual compounding would give them considerable elasticity of power without loss in yield, because with two pipes under different pressures, a moderate effective pressure, double or triple, according to the method of connecting the admission and exhaust, may be applied to the same cylinder. Advantage may thus be taken in the same cylinder with normal dimensions of the original economy afforded by low compression, because the possibility of admitting a threefold pressure would permit of overcoming a special resistance or making unusual efforts. In this manner successive stages of compounding introduced into the utilization apparatus would greatly increase the useful effect of moderating or governing, by permitting the dimensions of the motors to be reduced and the wire-drawing of the compressed air in the cylinder to be diminished."

The following suggestion regarding the possibilities in reheating is worthy of attention:

"While the other agents of power transmission, such as electricity and water under pressure, correspond with a strictly defined amount of energy available, compressed air, in addition to the amount of work which it is capable of giving out at a constant pressure and at the surrounding temperature, carries with it a credit, theoretically unlimited, for transforming into power the artificial heat which may be communicated to it; and this transformation is effected with so high a thermal yield that the supplementary work thus obtained is almost gratuitous.

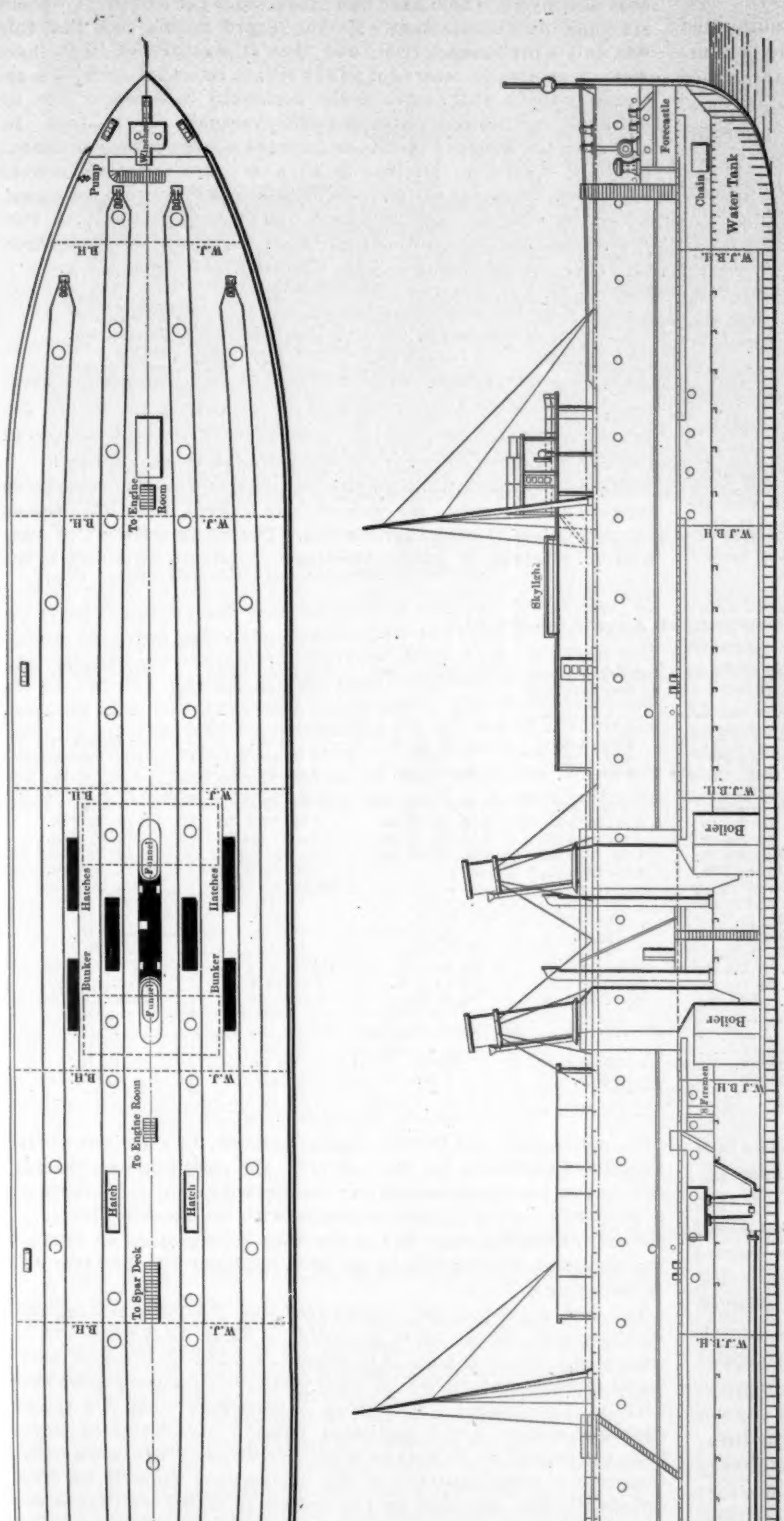
"In other words, the purchaser of a given weight of compressed air acquires at the same time the right of obtaining, without complication of any consequence, and with a very slight expenditure of fuel, an artificial quantum of energy at least equal to that of the natural energy imparted to it directly.

"This special faculty added to absolute elasticity of speed, both of the compressors and the motors, and also to the possibility of regulating or storing up compressed air, constitutes an individual feature of the highest importance, which may often justify a preference being given to this agent of power transmission."

The Record of a Flyer.

The Richmond Locomotive Works have published a handsome brochure entitled "A Record of a Flyer" on the Seaboard Air Line. This flyer was a directors' special, consisting of two heavy officers cars and one regular coach, hauled by a 19x24 eight wheeled engine, one of seven built for the road by the Richmond Locomotive Works in 1895, from the designs of Mr. W. T. Reed, Superintendent of Motive Power. The run was made November 21, 1896, between Weldon, N. C., and the Portsmouth (Va.) shops, the distance of 76.8 miles being covered in 72¼ minutes. This time is subject to a deduction of about five minutes, lost by reducing speed to comply with city ordinances at Seaboard, N. C., Franklin, Va., and Suffolk, Va., and in crossing Nottoway River, at which point a new bridge is under construction; this would leave the actual running time 67¼ minutes.

The engine is No. 540 and weighs 112,000 pounds, of which 75,000 pounds is on the drivers. The boiler is 58 inches in diameter, has 1,732 square feet of heating surface, 17.5 square feet of grate, and carries 180 pounds pressure. The drivers are 68 inches in diameter. The highest speed reached was 87 miles per hour.



THE NEW CAR FERRY "PERE MARQUETTE" FOR THE FLINT & PERE MARQUETTE RAILROAD.

Built by F. W. Wheeler & Co., West Bay City, Mich.

The New Car Ferry "Pere Marquette."

The latest addition to the fleet of car ferries on the great lakes is the boat *Pere Marquette*, built by F. W. Wheeler & Company, of West Bay City, Mich., for the Flint & Pere Marquette Railroad. It is a steel boat driven by twin screws, and is for service on the route across Lake Michigan between Manitowoc, Wis., and Ludington, Mich. The distance is about 53 miles.

In the accompanying illustrations we show a plan and a longitudinal section of the boat kindly furnished us by Mr. S. T. Crapo, general manager of the railroad company. The boat is 350 feet long, 56 feet beam, depth below main deck 19½ feet, and 36 feet 3 inches deep from upper deck to floor. It has four tracks and has a capacity of 30 cars. These, if fully loaded 60,000 pound cars, would weigh 1,350 tons. Carrying this load and 200 tons of fuel the draft of the ferryboat is 14 feet.

The vessel is entirely of steel and strongly built. The hull has six watertight transverse bulkheads dividing the hull into seven compartments. If any two of these compartments should be filled with water the steamer can still carry its load. The forward plating is ¾-inch thick and is double for a distance of 60 feet back of the stem. It is also double on the between decks beam strake. The side channels are 12 by 3 inches, and are spaced 24 inches centers amidships narrowing to 14 inches forward. Channel beams, thoroughly braced horizontally and vertically, extend across the hull, about midway between the floor and main deck. These are near the water line, and serve to resist the pressure of the ice encountered in winter service. About 2,700 tons of plates and angles were used in the construction of the hull.

The boat is propelled by twin screws 11 feet in diameter, driven by compound engines with cylinder 27 and 56 inches in diameter and 36 inches stroke. These engines develop a maximum of 3,500 indicated horse-power, and will give the boat a speed of 15 miles per hour. Steam is furnished by four cylindrical boilers, each 15 feet 3 inches in diameter and 12 feet long, and carrying a working pressure of 130 pounds per square inch. Each boiler has four furnaces. The boat's equipment of machinery includes a complete modern outfit of steam windlass, steam capstans, steam steering gear, etc., also an electric light plant and a 16-inch search light.

The deck houses are of wood. Besides the pilot house, there are ten staterooms forward, while aft there is a dining-room and kitchen, and quarters for the crew. The sleeping accommodations are sufficient for 25 passengers.

The boat presents none of the ungainly appearance that one is apt to associate with a car ferry, and altogether it is considered to be one of the finest examples of this class of steam vessels.

The Pullman Car Company has reduced its fares on the line between Cincinnati and Hannibal, Mo., via C. H. & D., I. D. & W., and Wabash roads. The seat fare in chair cars is now $1 and the distance is 417 miles.

The Effort to Establish a Standard 60,000-Pound Box Car.

The Ohio Falls Car Manufacturing Company, which inaugurated the movement among car builders to establish a standard box car, which it was proposed to follow in building for small roads or others who do not furnish drawings with their orders for cars, informs us, that the movement has met with much greater support than was anticipated. Regarding the matter they write:

"This support, however, is not in the nature of official co-operation by the railroad clubs, but in the favorable expression individually of a larger number of prominent railroad officials and car builders. It is the judgment of a majority in interest that the movement should have a wider scope then first intended and should embrace every important part left undecided by the forthcoming M. C. B. Convention in June. It has therefore been decided to continue the development of this plan until the convention announces its decision, and add to the standards then adopted an agreement covering as many parts as the car builders will unite upon.

"We enclose blue print summarizing the standards of the companies that have sent in reports to date. The variations are inconsequential and yet sufficient to prevent interchangeability, emphasizing the desirability of accomplishing the object in view."

maximum limit of speed so far attained by the largest torpedo-boat destroyers, which have more than twice her length and about six times her displacement. Having regard to the fact that this was only a preliminary trial, and that it was shown that there was a considerable reserve of power still to be called upon, it is anticipated that a still higher speed materially in excess of the remarkable result already attained will eventually be realized. In any case, the obtained results as recorded above are such as cannot fail to be of extreme interest to all naval architects and marine engineers. During the trial, there were present on board the vessel, among others, the Earl of Rosse, Chairman; the Hon. C. A. Parsons, Managing Director, and Mr. A. A. Campbell, Swinton, Director of the Marine Steam Turbine Company.—*The Steamship.*

Car Ventilation on the Pennsylvania Railroad.

Dr. Chas. B. Dudley, chief chemist of the Pennsylvania Railroad, gave an interesting lecture on car ventilation before the Franklin Institute last month. A brief summary of it is given in the Philadelphia *Ledger*, from which we take the following:

The Pennsylvania Railroad has been making a long and expensive series of experiments. No problem is so fraught with difficulties as the ventilation of passenger coaches. The whole question of ventilation, whether of public buildings or private dwellings, is but little understood, and there is a great variance in the views of distinguished architects on the subject. The conditions environing the ventilation of moving railway coaches with small cubic contents in proportion to the number of people, with the necessity for keeping out cinders and dust, and at the same time keeping an equable and agreeable temperature in the cars, rendered the problem one of exceeding difficulty.

DIMENSIONS PROPOSED FOR A STANDARD BOX CAR.

	Barney & Smith Car Co.	The Terre Haute Car and Mfg. Co.	The Elliot Car Co.	The Ohio Falls Car Mfg. Co.	United States Car Co.
Clear inside length	33 ft. 0½ in.	33 ft. 6 in.	34 ft.	34 ft.	33 ft. 4¼ in.
" " width	8 ft. 3½ in.	8 ft. 4 in.	8 ft.	8 ft. 2¼ in.	8 ft. 1¼ in.
" " height	7 ft. 2 in.	6 ft. 9 in.	6 ft. 11 in.	6 ft. 8¼ in.	7 ft. 0¼ in.
Door opening	5 ft.	5 ft.	6 ft.	5 ft. 6in.	5 ft. by 6 ft. 6½ in.
Center to center of center ties	6 ft. 10⅛ in.	4 ft. 6 in.	6 ft. 9 in.	6 ft. 3 in.	8 ft.
Section of side sills	5 in. by 8⅛ in.	5 in. by 9 in.	5 in. by 10 in.	5 in. by 9 in.	5 in. by 9 in.
" " center sills	5 in. by 8⅛ in.	5 in. by 9 in.	4 in. by 10 in.	5 in. by 8⅛ in.	5 in. by 9 in.
" " intermediate sill	5 in. by 8⅛ in.	4 in. by 9 in.	4 in. by 10 in.	5 in. by 8⅛ in.	5 in. by 9 in.
" " side plate	3½ in. by 7 in.	4 in. by 6 in.	....	3 in. by 6 in.	3 in. by 8 in.
" " end plate	3½ in. by 12 in.	....	....	3½ in. by 12 in.	3 in. by 13 in.
Height of lining	3 ft. 6 in.	3 ft. 6 in.	4 ft.	4 ft.	2 ft. 6 in.
Truss rod's diameter	1¼ in.	1⅛ in.	1⅛ in.	1⅛ in.	1¼ in.
" " end	1⅜ in.	1⅜ in.	1⅜ in.	1⅜ in.	1⅛ in.
Wheel spread	4 ft. 10 in.	5 ft.	5 ft. 6 in.	5 ft.	5 ft.
Upper arch bar	4 in. by 1¼ in.	1¼ in. by 4 in.	1¼ by 4 in.	1⅛ in. by 4 in.	1¼ in. by 4 in.
Lower " "	4 in. by 1⅛ in.	⅞ in. by 4 in.	1⅛ by 4 in.	1 in. by 4 in.	1 in. by 4 in.
Tie bar	4 in. by ⅝ in.	⅝ in. by 4 in.	⅝ in. 4 in.	½ in. by 4 in.	⅝ in. by 4 in.
Set of upper arch bar	....	....	....	5 in.	5 in.
Set of lower arch bar	....	....	....	12 in.	13 in.
Set of tie bar	....	....	....	1 in.	2¾ in.
Diameter of column bolts	1⅜ in.	1⅜ in.	1¼ in.	1¼ in.	1¼ in.
" " oil box "	1⅛ in.	1⅛ in.	1 in.	1 in.	1⅛ in.

We give herewith the tabulated statement contained in the blue print mentioned. It will be evident from a perusal of these figures, few as they are, that the differences in dimensions existing to-day are not vital, and that small compromises between those interested would result in the use of one design. As we said editorally two months ago, there is no good reason why the movement should not result ultimately in a standard car adopted by the Master Car Builders' Association and the railroads, as well as the car builders. This outcome of the movement is greatly to be desired, and we hope to see it achieved. The determination to continue the work and include in it many parts of the car not found enumerated in the above list, is a step in the right direction, and the announced intention to incorporate in the standard every detail standardized by the M. C. B. Association shows that there is no intention on the part of any one to usurp the privileges or duties of the association.

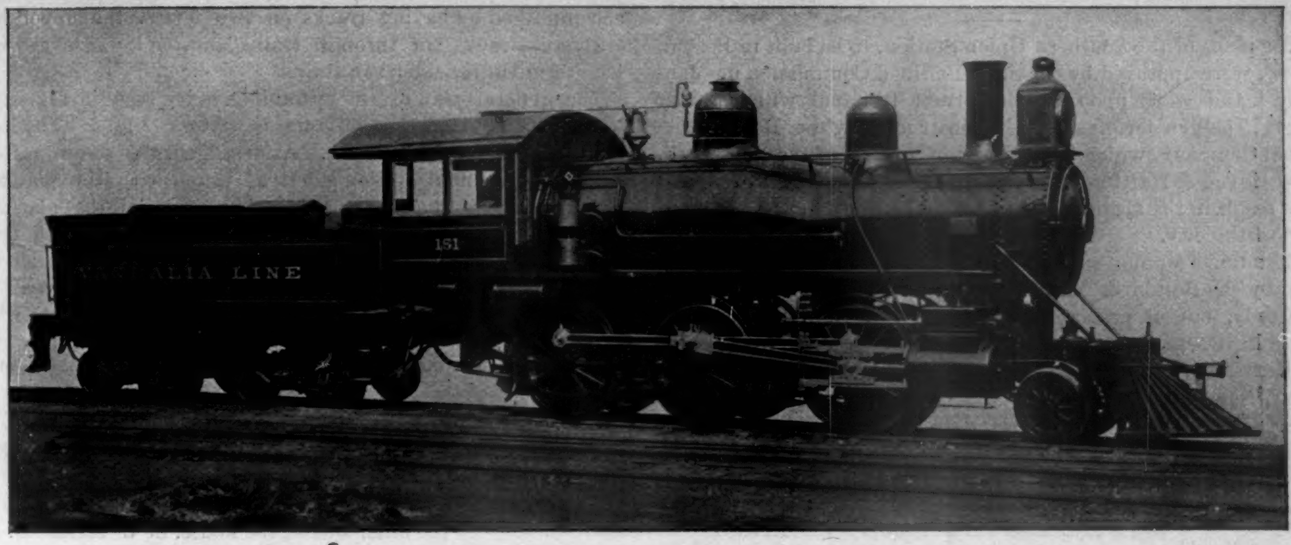
Trial of the Steam Turbine for Marine Propulsion.

The torpedo boat *Turbinia*, built at Wallsend by the Marine Steam Turbine Company, Limited, for the purpose of testing the application to marine populsion of the Parsons' steam turbine, went for a trial trip on December 15. Several most successful runs were made, and the very high speed of 29.6 knots was attained over the measured mile. It is believed that this is a speed greatly in excess of anything that has ever been previously accomplished by a vessel of the small dimensions of the *Turbinia*, which is only 100 eet in length, 9 feet in beam, and has but 42 tons of displacement when fully loaded. Indeed, the speed already attained upon this preliminary trial trip by this small boat nearly approaches the

The first point definitely determined was that the heating and ventilation of the car must go hand in hand; they could not be separated. The next point is to know how many cubic feet of fresh, warm air must be supplied to each person to constitute good ventilation. Conclusions drawn from experiments made in England show that a space is well ventilated when a person coming into it from the outside air detects no odor. Experiment has shown that the carbonic oxide naturally in the atmosphere, which is the deleterious element, amounts to 4 cubic feet in 10,000, and that by the addition of 2 cubic feet more of carbonic oxide, an odor may be detected. This, then, is the measure of ventilation. An average person gives off 6-10 of a cubic foot of carbonic oxide each hour. With this data it is figured that 3,000 cubic feet per person of pure air must be supplied to ventilate a car, and for a car containing 60 persons this means that the total air in that car must be changed every 80 seconds, or 45 times an hour. It would be impracticable to do this and heat the air from zero to 70 degrees.

The experiments made by the company had been based upon supplying half of the 3,000 cubic feet per passenger, and to heat 12 cars, which is about the size of the trains on the main line, would require about 3½ per cent. of the steam which the locomotive could produce.

Experiments have been made with a system of steam pipes running the whole length of the car on each side, in the same place as the heat-box in the present system, but just under the floor. The



MOGUL LOCOMOTIVE FOR THE VANDALIA LINE.

Built by the Pittsburgh Locomotive Works. **Mr. W. C. Arp, Superintendent of Motive Power.**

air is led from the hood near the roof, at the end of the car, as before, to a box under the steam pipes, and rises through openings into the box containing the pipes, from which it passes into the car through openings in the floor. These apertures are 4 inches long and 1¼ inches wide and 4 inches apart. The ventilators must have the same capacity for discharging the air, and 20 of these are distributed along the roof of the car. The result obtained with a car so equipped was a circulation of 90,000 cubic feet of air per hour. The snag which was struck was that, with such a supply of air, the temperature of the car was only 40 degrees, when the outside air was zero.

The company had reached a point where it could furnish one half the theoretical amount of air required, but could not warm it in zero weather. It was thought that during extreme weather a little poorer ventilation might be endured for a month or two. The question of smoke, cinders and dust had not been touched thus far.

The problem now stands thus: It is possible to get a great deal more air into a car than by any other known system; if passengers could content themselves with 20,000 or 30,000 cubic feet instead of 90,000 per hour, the air could be supplied properly heated and the system could be put on cars at once. On the other hand, there are 2,500 passenger cars to be equipped, and it is a very expensive operation. It has, therefore been deemed advisable to experiment further and exhaust the subject before making any change.

New Mogul Locomotives on the Vandalia Line.

Some months ago the Vandalia line received some new mogul locomotives from the Pittsburgh Locomotive Works, and through the courtesy of Mr. W. C. Arp, Superintendent of Motive Power, we have received the diagram and photograph given herewith. In a letter to us regarding them, Mr. Arp says: "These engines are used in freight service on the main line between Indianapolis and St. Louis. There are practically three divisions, but our intention is to run them 165 miles from Terra Haute to St. Louis, and 75 miles from Terre Haute to Indianapolis. On the division between Terre Haute and Indianapolis the engines are rated at 950 tons; on the Western division, 1,000 tons. The performance of these engines is very satisfactory."

The engines have 20 by 26 inch cylinders and driving wheels 62 inches in diameter. These wheels are of a more suitable diameter for good freight work than smaller ones would be, when the cylinders are large enough to turn them, and will reduce the cost of maintenance. The boilers have a total of 2,129 square feet of heating surface and the grate area is 30.6 square feet. Some of the leading dimensions are given in the outline sketch and others will be found below:

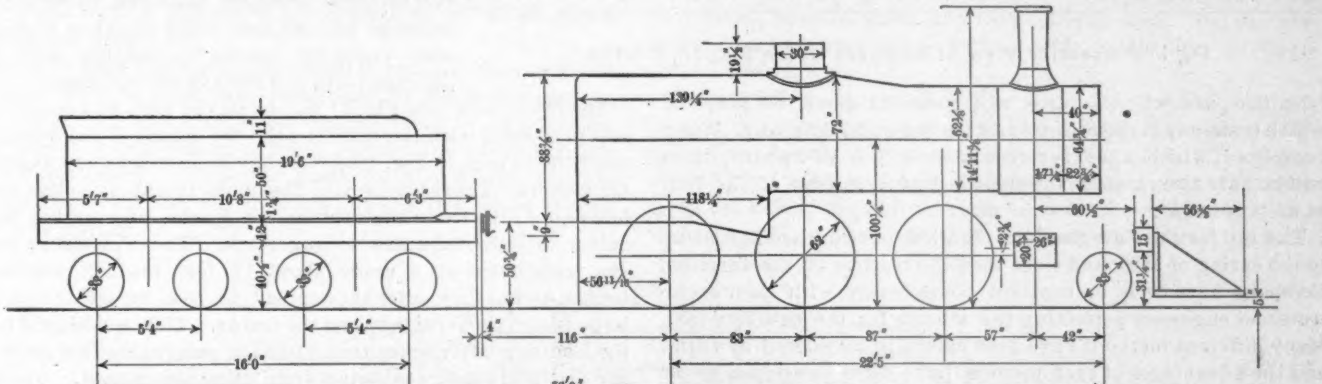


Diagram of Vandalia Locomotive.

Type	Mogul
Fuel	Bituminous coal
Gage of track	4 feet 8½ inches
Total weight of engine in working order	142,000 pounds
" " " " on drivers	127,000 pounds
Driving wheel base of engine	14 feet 2 inches
Total " " " "	22 feet 5 inches
" " " " " and tender	51 feet 8 inches
Height from rail to top of stack	14 feet 11⅝ inches
Cylinders, diameter and stroke	20 by 26 inches
Piston rods	Steel, 3½ inches diameter
Type of boiler	Extended wagon top
Diameter of boiler at smallest ring	62 inches
" " " " back head	72 inches
Crown sheet supported by one-inch radial stay bolts, 1 inch diameter, spaced four inches from center to center.	
Number of tubes	318
Diameter " "	2 inches
Length of tubes over tube sheets	12 feet
" of firebox, inside	108 inches
Width of " "	41 inches
Working pressure	185 pounds
Kind of grates	Cast iron, rocking
Heating surface in tubes	1,950 square feet
" " in firebox	179 " "
Total heating surface	2,129 " "
Grate area	30.6 " "
Diameter of driving wheels outside of tires	62 inches
" and length of journals	8½ by 11 inches
" of engine truck wheels	33 inches
" and length of journals	6 by 10 inches
Type of tank	Level top
Water capacity of tank	4,0 0 United States gallons
Fuel " " "	280 cubic feet
Weight of tender with water and fuel	81,400 pounds
Type of brakes	Westinghouse American

The Southern Union Station in Boston.

The plans of the Southern Union Station, to be built in Boston, Mass., were approved by the State Railroad Commission on January 4, and work upon this important terminal will begin at once. The new terminal is to be constructed by the Boston Terminal Company, which is composed of officers of the New York, New Haven & Hartford, and the Boston & Albany railroads, and will result in the abandonment of four stations in the southern part of the city.

Boston has a union station on the north side of the city, occupied by the Boston & Maine, Boston & Lowell, and Fitchburg railroads, but at present the lines entering the city from the south have separate terminals, as follows: New York, New Haven & Hartford (Providence Division), Park Square Station; New York, New Haven & Hartford (Old Colony Division), Kneeland street; Boston & Albany, Kneeland street; and until its absorption the New England road used the station on Summer street. The new terminal is to be erected on the ground of the New England terminals, and with its yards will cover 40 acres, 30 acres of which is already in the possession of the Terminal Company. When completed, which it is expected will be within 18 months, there will be only two passenger stations in Boston instead of the four in use at present.

Fig 1.—Persective View of Southern Union Station, Boston.

The bill for the New Southern Station passed the Legislature in the spring of 1896, and since then the trustees of the Terminal Company have been in constant consultation with their architects and engineers perfecting the scheme for the new terminal. Many different methods have been carefully considered by them, and the advantages of each method have been developed as far as possible. They now feel that they have selected from all the methods under consideration those which will give the best practical results. Important changes have been made in the arrangement of tracks and platforms since the plans were presented last spring, which have greatly increased the train capacity of the terminal. At that time the problem was to show the adaptability of the locality for station purposes, but that point being conceded, the problem changed to one of best development of the territory.

It has long been recognized that the suburban, or commutation, passenger traffic of the steam railroad is different in character from the passenger traffic which goes beyond the commutation points. The suburbs of Boston are numerous and contain a large population, thus making the handling of the suburban traffic an important problem. At the present stations whose traffic is to enter the new station about 25 tracks are used for passenger service, and they are even now evertaxed. The stub-track system in the new station provided 28 tracks, hardly more than the number now needed and offering no expansion for the future large increase of suburban traffic that already comprises two-thirds of the whole. The switch systems at the point where the station tracks branch out from the main tracks are generally congested after serving 20 or more tracks. At the present southern and western stations there are in the neighborhood of 3,800 switch movements through these switch systems in a day of 18 hours. To adequately provide for the suburban traffic, it was therefore decided to separate it almost wholly from other service. This is accomplished by having tracks on two levels, the upper level with stub-tracks for through trains, and the lower level with a loop terminal for suburban trains.

The general plan of the terminal is to be seen in Fig. 1, and the perspective of the building is given in Fig. 2. The lower level loop is shown in Fig. 3. As arranged, the steam railroad stub-track terminal station is left as usual, with the platforms five feet above the street grade, but with all the platforms reached without the use of steps. This level is devoted to the usual trains which go beyond commutation points and such suburban trains as it may be desirable to keep on that level. The lower level is to be used exclusively for suburban trains which may be run with electricity for a motive power, or any other suitable motive power which avoids the nuisance of steam, gas and smoke.

The upper floor will be provided with 28 stub-tracks, so arranged in connection with the switches to the main-line tracks of each road that all outgoing trains may leave from one side of the train-house and all incoming trains enter on the other side of the house, or if preferred, the train-house may be divided into two grand divisions, one of which shall be used by the roads going out over the Providence Division and the Boston & Albany Railroad, and the other by the trains of the New England and Old Colony. These 28 tracks will hold about 350 passenger cars when completely filled. There will be seven platforms the entire lengthof the train-house dovoted exclusively to the trucking of baggage and express matter altogether out of the way of the passengers, and at the end of these trucking platforms there will be baggage and express truck elevators to a subway under the tracks connecting with the baggage-room and the express buildings.

The lower floor (see Fig. 3) will be served with two loop tracks which connect with the main tracks by means of the depressed yard tracks seen in Fig. 1 between the main tracks and Dorchester avenue. These tracks join the main tracks at points about one-half a mile from the station, the grades and curves being suited to light suburban rolling stock. The loop tracks enter the train-house at a grade about 17 feet beneath the stub-tracks, and as they enter they spread to pass on either side of a large island platform between the tracks. This is designed to be the loading platform, so that outgoing passengers can go to the one platform for any suburban train using the station. The two outside platforms will be for unloading the passengers from incoming trains. These platforms are of such length that 14 trains of three cars each may stand next to them, seven on each track. It is said that if it becomes necessary to send out one train a

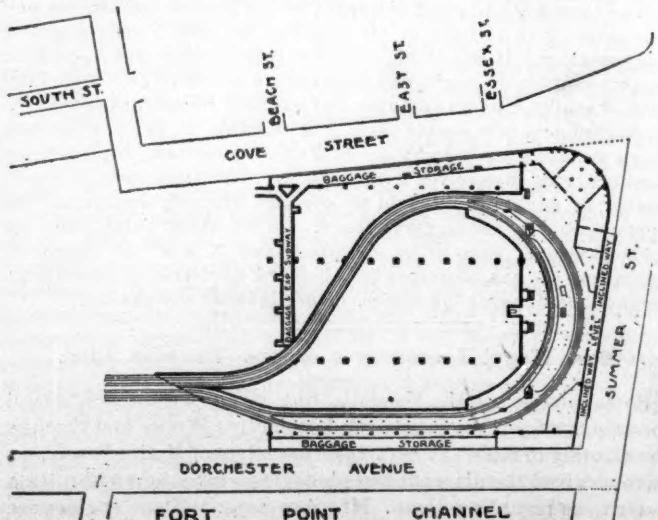


Fig. 3.—Plan of Loop Tracks on Lower Level, South Union Station, Boston.

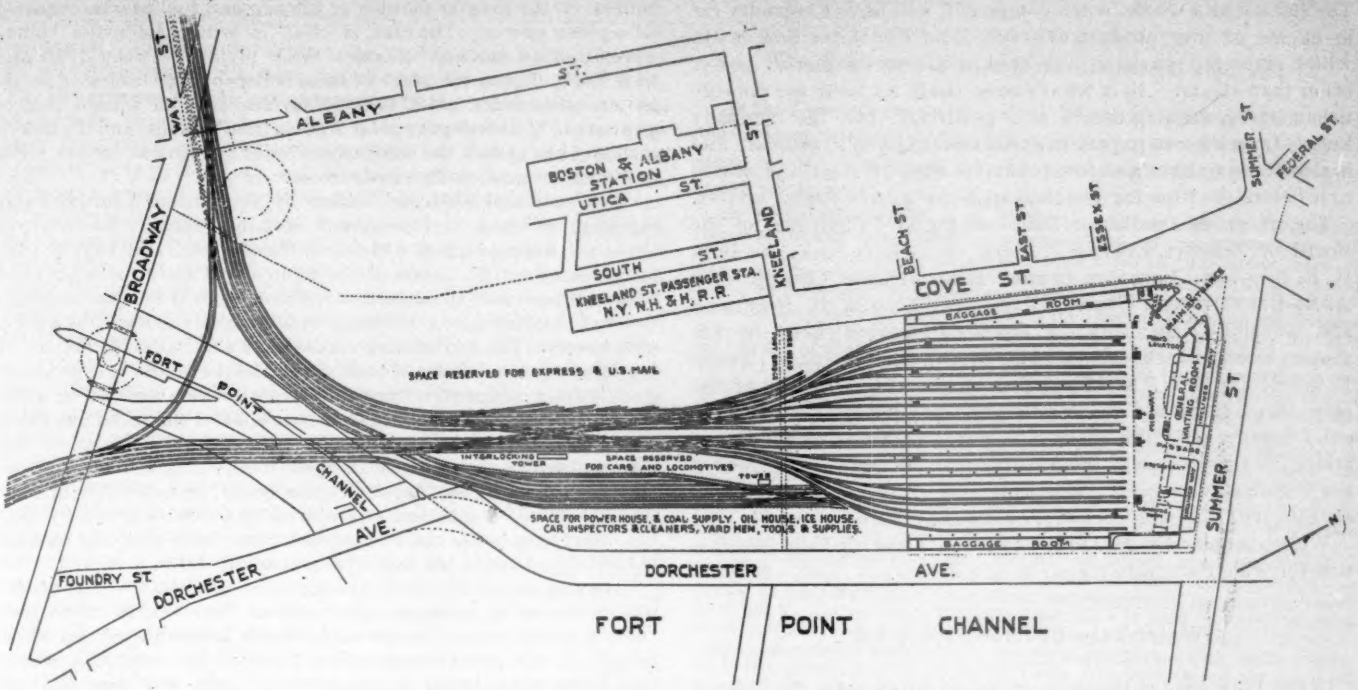


Fig. 2.—General Plan of South Union Station, Boston.

minute it can be done, and then each train will remain in the station four or more minutes for unloading and loading. This means upward of 2,000 trains in and out in each day of 18 hours upon these two tracks alone, which is five times as many as are at present run in the suburban service. The platform area devoted to this service will allow an assembling of about 25,000 people at one time.

These two floor levels are about equal in vertical distance above and below the level of Summer street, and all passengers may go to and from the street without the use of stairs to either floor.

The switch system will be operated through the pneumatic system of interlocking. The power plant for the whole terminal will be a large one, and will be located on the Dorchester avenue side of the station.

general offices, and also to restaurant-rooms in addition to those provided on the first story. The third, fourth and fifth stories will be occupied by the offices of the several railroad companies forming the Terminal Company. In addition to the main entrance access to the trains of the upper level is provided from Cove street, Summer street and Dorchester avenue. The passage on the Summer street side is 44 feet wide, while that on Cove street is 25 feet.

The general waiting-room will be 65 by 225 feet, and will extend up two stories, being about 28 feet high to the upper side of the ceiling beams, these beams being 4 feet deep. The ticket office, 12 by 92 feet, will have 24 ticket windows, and will extend along the side of the waiting-room between the midway and the waiting-room. At the end of the waiting-room, near the main

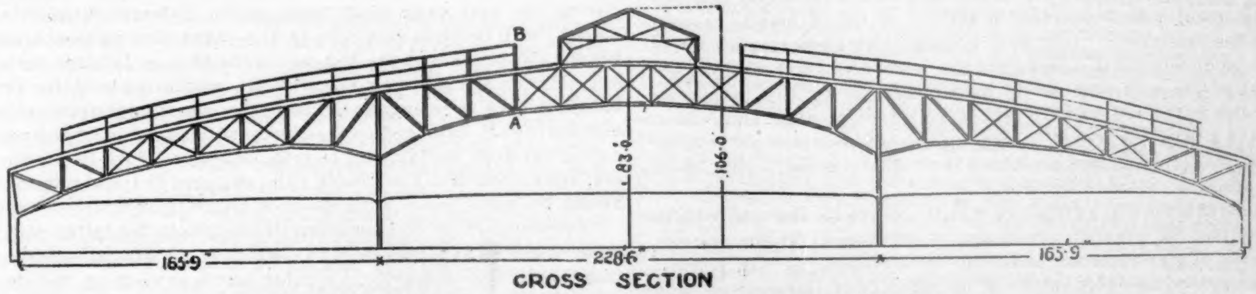


Fig. 4.—Section Through Train Shed, South Union Station, Boston.

The head-house will contain offices for all the railways entering the station. At the corner of the building at the junction of Summer and Cove streets there will be a main entrance 92 feet in width. The curved front at this point is 228 feet long, and from it the main building extends 324 feet on Summer street and the same distance on Cove street. Beyond the main building on Cove street the baggage-room will extend a distance of 350 feet. On Summer street a two-story building will extend from the main building to the corner of Dorchester avenue, and along the whole frontage on this avenue. The first floor on the Dorchester avenue side will be devoted to a carriage concourse and to baggage, while the second floor will be occupied by rooms for conductors, trainmen, stores, etc. On Summer street the building will be set back 20 feet from the lot line to admit of inclined ways down to the suburban level, and these ways and the sidewalk will be covered by an awning of glass and metal. The first story and basement of this main building are to be devoted entirely to railroad purposes, the second story to offices of the Terminal Company and

entrance, will be a women's room, 22 by 34¼ feet, with a lavatory 40 by 40 feet. On the main floor will be a restaurant, 68 by 73 feet, a portion of this space being devoted to a lunch counter. A private dining-room will be on the second story. The kitchen and bakery will be on the second floor. There will also be a barber shop, 34 by 42½ feet, provided with bathrooms on a gallery, and bootblack-room in close connection; a stationmaster's room; smoking-room, 37 by 60 feet, and men's lavatories, carriage offices, telegraph and telephone offices, bureau of information, newspaper stands, etc., are provided.

The train shed will be in three spans, and a roof of one sweep, which, together with the roofs over the baggage-rooms and midway, will make a roof of over 700 feet long and 650 feet wide, this being the largest railway building roof in the world, nearly 10 acres. Just as we go to press word comes that the contract for the steel work of this train shed has been given to the Pennsylvania Steel Company. The contract is for about 7,000 tons of steel, and the price is said to be between $300,000 and $400,000.

The station as a whole, when completed, will have a capacity far in excess of any other in existence, and will be the first one in which elaborate provision has been made for a motive power other than steam. As to what power shall be used for the suburban traffic, nothing can be said positively, but the company knows from its own experience that electricity is a success, and it also hopes to have a successful compressed air system presented to it before the time for deciding upon the motive power arrives.

The officers of the Boston Terminal Co. are: Chairman of the Board of Trustees, Charles P. Clark (President N. Y., N. H. & H. R. R.); Vice-Chairman, Samuel Hoar (General Counsel, B. & A. R. R.); Trustees, Chas. L. Lovering, Francis L. Higginson and Royal C. Taft; Manager, John C. Sanborn; Resident Engineer, George B. Francis, M. Am. Soc. C. E.; Treasurer, Charles F. Conn; Clerk, W. Perkins. The engineering features of the plan were developed by Mr. Francis, in consultation with the chief engineers of the roads which will enter the terminal, and under the supervision of the board of trustees and the manager of the Terminal Company. The architects of the station building are Shepley, Rutan & Coolidge, of Boston.

We are indebted to Mr. Francis for the plans and the information for which we have prepared this article.

Water-Tube Boilers—Liquid Fuel.

In the *Year Book* of the Office of Naval Intelligence, just issued, considerable space is given to water tube boilers. After a description of Mr. Yarrow's experiments made in January, 1896, the report goes on to say that great differences of opinion are still held by authorities on the relative merits of Scotch and water-tube boilers, and on the efficiency of the various types of the latter. Mr. Durston, Engineer-in-Chief of the British navy, says:

"The general question of the use of higher steam pressures, which necessarily involve, in my opinion, the use of water-tube boilers, will be of interest, . . . and if it be shown by experience that increased pressures can be obtained with water-tube boilers with safety and efficiency, and that a considerable gain in economy results from the use of such high pressures, no doubt the mercantile marine will be forced by competition to their adoption, assuming, of course, that any practical difficulties are shown by experience to be overcome when proper appliances are fitted. One very important reason for the adoption of very high pressures exists in the navy, however, to a much larger extent than in the mercantile marine, and follows from the fact that with naval machinery the usual power exerted in service is but a small proportion of the full power. It is well known that such small powers cannot be developed in a large engine with economy, and one advantage of the provision of very high pressures for the maximum power lies in the reduced size of engine which results, and which will have a beneficial effect in making the engine more economical at those low cruising powers which the vessel exerts during most of her life.

Besides this special advantage which accrues in the navy, there is, of course, the general advantage of lightness. There are certain types of war vessels where the development of the highest possible power for short spurts is of paramount importance, and this highest possible power is required on the lowest possible weight of machinery."

A series of experiments has been carried on at Devonport to determine the distribution of temperature over the tubes and tube plates of boilers, and the results showed that tubes remained tight up to a temperature of 750 degrees Fahrenheit, but above this leakage must be expected; that the loss of efficiency due even to a slight deposit of grease in the boiler was about 11 per cent., and that brass and copper tubes were more liable to leakage than steel and iron tubes. In consequence the brass and copper tubes, where used, are being replaced by steel tubes in the British service.

The *Year Book* says that the adoption of the Belleville water-tube boiler for certain of the larger vessels of the British navy has met with disapproval on the part of many engineers who consider that this boiler has not yet proved its superioity to the Scotch boiler as a steam generator for large vessels. Trials are quoted as showing the wastefulness of the Belleville boiler and serve as an argument against their use. The two vital objections urged against water-tube boilers by their opponents, and which the Admiralty is claimed to have overlooked, are: (1) The greater coal consumption per indicated horse power per hour as compared with cylindrical boilers; (2) the greater number of firemen and coal-passers required for a given power. The case is cited in which Belleville boilers were fitted in the new steamer *Ohio*, plying between Hull and New York. There were four of these boilers of 2,000 indicated horse-power, 6,000 square feet of heating surface, and 192 square feet of grate area. The tubes gave great trouble from leakage, and the lack of economy has caused the company to order cylindrical boilers for a new steamer now under construction.

The adoption of Bellville boilers by the British Admiralty was severely criticised in Parliament in June, when it was charged that they were adopted without sufficient trial, and that if they proved a failure 23 vessels of the navy would have to be supplied with new boilers. The Admiralty, however, held that the strategic value of the boiler, in gettting up steam rapidly, outweighs all disadvantages. The advantages claimed for the Belleville boilers by the Admiralty in defense of their action are the ability to raise steam quickly from cold water; the rapidity with which fires can be withdrawn, the grates cleaned, the tubes swept and the boiler put under steam pressure again; a control of steam pressure so complete that the engines can be suddenly stopped from full speed without the pressure rising or any injury to the boiler; less liability of fatal consequences if the boilers are injured in action; and finally, that the water-tube boiler can be removed from a ship with less damage to the latter than in the case of a cylindrical boiler.

Time and experience will develop the practical value of the water-tube boiler for large war vessels. Their value in torpedo vessels, where great powers and speeds are required for short periods, is now generally co ceded. France has used the water-tube boiler in her larger vessels for some years and does not discard them for inefficiency, and other powers are extending their use of them. The largest installations in the British Navy are those in the sister cruisers *Terrible* and *Powerful*. In the *Terrible* there are 48 boilers, located in eight boiler rooms, and arranged symmetrically on each side of a central longitudinal bulkhead. The boilers stand transversely in the ship. The total grate area is 2,200 square feet, and the heating surface 67,800 square feet, the ratio between the two being 1:30.8. The horse-power is 25,000. The steam pressure is 260 pounds, reduced to 210 pounds at the engine.

On the subjects of water-tube boilers and liquid fuel, Commodore Melville in his recent annual reports says:

"The water-tube boiler question is one that is absorbing the attention of all designers of naval machinery, and the aim in all cases seems to be to get a boiler which, while being reasonably light, shall be capable of ready repair in case of a ruptured tube, and contain so much water that a slight derangement of the feed apparatus will not result in burning out the boiler. The Bureau during the past year made tests of two different types of these boilers, both being in steamers on the lakes, the owners of which kindly placed them at the disposal of the Bureau for such tests and examination as could be made without interfering with the service on which they were engaged. The first steamer experimented with, the *Northwest*, belonged to the Northern Steamship Company, and plying between Buffalo and Duluth, was fitted with Belleville boilers; the second one, the *Zenith City*, engaged in freight service between the same ports, with Babcock and Wilcox boilers.

"For the purpose of comparing the results in the latter case with what might be expected from the ordinary cylindrical boilers under like conditions of service, a similar test was made on the steamer *Victory*, belonging to the same company as the *Zenith City*, and practically identical with her in all respects save boilers. As a result of the three tests above mentioned, and a further evaporative test of a Babcock & Wilcox boiler by the Bureau, it was decided to fit this type of boiler in the *Chicago* for about 4,500 indicated horse-power—one-half her power. Subsequently to the award of contract, the Department, upon the recommendation of the Bureau, approved the request of the contractors for the construction of gunboat No. 10 and for gunboat No. 15, to supply this type of boiler instead of the cylindrical one of the original design; and the fitting of this boiler in those two classes of gunboats will give an excellent opportunity to demonstrate its value as compared with the cylindrical boilers fitted in the other gunboats of the same class.

"The experiments conducted at the New York Navy Yard in using liquid fuel in the third-class torpedo-boat of the *Maine* have been completed. The evaporative results were good, even at the highest rates of combustion, and it only remains to ascertain whether the stowage and carrying of this fuel can be so effected as to eliminate danger from the gas that may be given off, which is the one objection to the use of any fuel oil other than petroleum refuse. It is to be regretted that conditions, other than those per-

taining to the system of burning the fuel in these boats, operated to prevent a trial of the boat in free route for any length of time. The Department having authorized the fitting of this system in one of our tugs, in order to demonstrate its practicability under ordinary conditions of service, preparations are being made to use 'fuel oil' only in this boat, and it is hoped that the results will be such as to warrant its general use for tugs and torpedo-boats."

In the use of petroleum, now constantly increasing in favor as a fuel for marine boilers, France takes the lead, using it in mixed combustion with coal. The *Year Book* says that all the new vessels of the French navy will be fitted for burning this auxiliary fuel, and the vessels in commission will also have their boilers converted for this purpose. The petroleum used is refuse oil, of the consistency of thin molasses, of a yellowish color, and comparatively odorless. The liquid fuel is admitted to the furnaces in the form of spray, greatly increasing the intensity of the heat, and in proportion to the amount of petroleum so admitted. The use of forced draft is thereby avoided with the consequent discomfort of the closed fire room; and means are provided of quickly increasing the speed without increasing the labor. The wear and tear on the boilers is less than that produced by forcing the draft. The only waste is that of the fresh water expended in pulverizing the petroleum, for which live steam is required. The various types of pulverizers are shown in an article on liquid fuel by Col. N. Soliani in the "Transactions of the World's Columbian Exposition Engineering Congress," which also gives some results of the use of liquid fuel in Italy. Mr. Jules d'Allest has published another valuable addition to the literature on this important subject.

In the French service the ratio of petroleum to coal burned varies from 0.17 to 0.65, depending on the vessel, type of boiler, thickness of the fire and degree of forcing required. The heating efficiency of petroleum compared to that of coal is as 10 or 12 to 8. The increased expense of the petroleum prevents its sole use as a fuel, the Russian article delivered in France costing at least price the cost of coal, not taking into account the duties imposed.

A liquid fuel installation consists of: (1) A storage tank holding about six tons, placed high in the bunkers to aid the flow of the oil; (2) a pump on the floor of the fire room, which pumps the oil from the tank to a reservoir; (3) a reservoir, consisting of a metal cylinder holding 35 gallons, where the oil is under a slight pressure; (4) a burner for each furnace, with piping from reservoir; (5) piping to conduct live steam to the burners to pulvarize the petroleum. The force and fineness of the spray is controlled by valves in the burner, and a shower of pulverized oil is distributed over the surface of the fires.

It has been shown that by using the petroleum the speed may be increased from eight to thirteen knots in from seven to fifteen minutes, without increasing the expenditure of coal. The larger vessels will carry from 60 to 80 tons of the liquid fuel. It is urged by some that torpedo boats use liquid fuel only, on the ground that for these small vessels it may be made as cheap as coal, after carefully developing the system of combustion to the highest possible state of efficiency. A type of boiler for the sole use of petroleum has been designed by Mr. Seigle, and is under consideration by the French Navy Department. Great results are claimed for this boiler, the principal characteristics of which are: (1) Complete and direct utilization of the heat produced and rapid circulation of the water; (2) division of the single furnace into a number of tubular telescopic furnaces so as to increase the heating surface and consume the fuel regularly; (3) perfect combustion, the gasses issuing from the smoke pipe being without trace of carbon monoxide.

Germany is beginning to use liquid fuel more extensively and Italy is installing it in all torpedo boats. It is stated on later authority than the *Year Book* that the German naval authorities have decided to equip all the existing large men-of-war in the German navy with apparatus for burning oil with coal under the boilers, and the use of liquid fuel will, it is stated, be provided for in all new vessels. The oil will be stored on board in special tanks, from which it will be pumped to the furnace and ejected in a spray by steam. For the storage on shore of the liquid fuel in large quantities, reservoirs holding over 100,000 gallons have been built at Wilhelmshaven, and similar tanks are to be put up at Kiel and Dantzic.

The trials of the new British cruiser *Terrible*, a sister ship to the famous *Powerful*, were as satisfactory as those of the latter vessel. On the first trial, with about 18,000 horse-power and with 102 revolutions of the starboard engines and 100 of the port, the mean indicated horse-power was 18,493 for the 30 hours, and the speed of the vessel, as taken during three hours' run on the measured distance, was slightly under 21 knots. With 112 revolutions per minute starboard and 111 port, and a total horse-power of 25,572, a speed of 22.41 knots was obtained.

The Uses and Limitations of Compressed Air.

At the December meeting of the Western Railway Club there was a most instructive discussion on the paper on compressed air read by Mr. McConnell at the preceding meeting. We give below an abstract of the discussion:

Mr. Geo. Gibbs (C., M. & St. P. Ry.): I think that Mr. McConnell has cited some very sensible applications of compressed air for shop use, and I entirely agree with him until in the latter part of his paper he mentions some uses to which I think compressed air is not well adapted. He mentions having a three-cylinder Brotherhood engine operated by air, which he uses for running an 18-inch slotter, a 42 by 42-inch planer, and for wheel lathes; and, further, he speaks of the use of an air engine for running a transfer table of 100 feet travel. I believe in these instances he is going entirely out of the legitimate field for use of compressed air. He also speaks of doing away with line shafting entirely. "No main line shafting extending the entire length of the shop is necessary. A short line shaft may be used for heavy machinery and all the light machinery may be driven by air." There he is treading entirely upon the province of the electric motor, in my opinion. I am not able to present now a thoroughly digested statement of just what the two fields are; but, immediately before the meeting, I jotted down some general headings of groups under which I think the two agents might severally be used to advantage. In railroad shops compressed air is adapted—First: For short hoists or direct lifting operations, such as jacks, and air hoists for unloading car wheels and for placing heavy weights on lathes and planers. Second: It may be used for pressure tools, or light work like stamping and pumping. Third: It may be used for working a tool for striking short, quick, light blows, such as riveting and caulking tools for boilers. Fourth: It is adapted to air-blast purposes, such as mixing paints and white-washing. As a fifth use might be mentioned its employment for transferring oils from cars to tanks in oil-houses. When these five headings are considered I think we have about got to the end of the catalogue of cases in which air can be used to special advantage, although, of course, there are many other places where it can be used, but not as economically as could some other agency. The uses to which I consider electricity adapted for are:

First, for lifting purposes, such as in traveling cranes. Second, for conveying operations, such as in transfer tables and traveling cranes. Third, for rotary power tools, which would comprehend the general group of individual motors for running large machine tools; also small special motors adapted for drilling and tapping. This drilling and staybolt tapping has been done by air tools, but I think it can be done much more satisfactorily by motors, although I confess that I have not seen any motor which has been put on the market which completely fulfills the conditions of the requisite lightness and reliability. The urgent demand for this class of electric tools will, however, doubtless result in their being forthcoming in the near future.

Mr. C. H. Quereau (B. & M. R. R.): Admitting all the economy to be obtained by the use of compressed air in the shops, there is such a thing as carrying it too far, and in saying this I do not wish to be understood as adversely criticising Mr. McConnell's paper. To illustrate: One of my friends recently said that he had some revelations as to the value of labor-saving devices when he came to put his men upon piece work in repairing locomotives. Most roundhouses are fitted with stack lifts for taking the steam-chest covers off and lifting the valve out. When this operation was put on piece work, a couple of men would take a stick and lift that steam chest off while they could adjust the stack lift. It is apparent that compressed air is not always economical, though it may be a convenience. I think it is a subject that will bear considerable investigation and considerable discussion before arriving at a final conclusion for any given use, and I think the system of piece work will give us data and some enlightenment on that point.

Mr. J. F. Deems (C., B. & Q. R. R.): Mr. Connel's paper brought to my mind an experience which I had a year or two ago and some impressions or convictions growing out of that experience, all of which was very much in line with the last speaker's remarks.

We introduced piece work into one of our roundhouses and locomotive repair shops and you can imagine my surprise when I found some of the tools, which we had looked upon as the very best, cast into the corner and not used at all, one of them being the small crane for lifting steam chests to and from their places on the engine, such as Mr. Quereau speaks of as having seen in another place where it suffered the same fate on the introduction of the piece-work system. The same was true of some of the other devices, which, as the piece work was extended more and more, fell into disuse, showing conclusively that while they might be marvels of mechanical skill and might afford their designers much satisfaction on display occasions, they were not in the proper sense of the word labor savers and hence not revenue producers. This was by no means true of all such appliancers, in fact, the introduction of piece work resulted in bringing out some new ones. But I venture to say that to-day there are many lathes or other machine tools supplied with air hoists where time is continually wasted in getting such hoists into position and making hitches to raise work into the machines which could be lifted into place with one hand in half the time it takes to make the hitch. The same is true of apparatus that I have seen used in car repair yards for lifting draw-bars into position. It would take more time to get the machine to the point where it was to be used and get the drawbar into position on the machine than it would to get it into place on the car with the old-fashioned "armstrong" method.

I believe that if the same amount of time and energy had been expended during the past four or five years in introducing and perfecting this or some other better method of handling men, that has been spent in getting up novel machinery for the men to use in handling the work, the results would have been much more satis-

factory from a financial standpoint. If there was the same spirit of rivalry between shop foremen to display their business ability in handling their shops that there is to display their mechanical skill in getting up these complicated devices, the result, in my opinion, would be a net gain.

Mr. B. W. Thurtell (Consulting Engineer): The lack of economy in the use of compressed air is due to the prevailing method of compressing. Old direct-acting pumps are often used without expansion, and these use from 110 to 150 pounds of water per horse-power per hour; whereas, if a modern compressor with a modern type of Corliss engine were used, only 30 pounds of water per horse-power per hour would be required and we would get satisfactory economy. Mr. Kolbe, Chief Engineer of the St. Louis Bridge and Terminal Association, whose plant is located in East St. Louis, has two air compressors. The compressors were small, yet they were able to do the work running at a speed of 80 revolutions per minute; soon, however, more work being added, the speed was increased until they were running up to 250 revolutions per minute. Steel air valves were used and the duty was so great that new valves were required every other day owing to the excessive wear. At that plant the compressed air is used for the switch and signal system, also for a slide valve engine to run a machine shop about three-quarters of a mile from the power plant, and this is done without loss in pressure in the receiver. An air pipe is laid across the Eads Bridge to St. Louis, where power is rented which nets an income of 20 per cent. of the cost of operating the compressed-air plant.

Mr. T. Symington (Richmond Locomotive Works): Mr. McConnell estimates that he saves $10,000 a year by the use of his various appliances. We have spent a great deal of money in Richmond on air machinery, and we believe that pneumatic transmission has come to stay. While the field is to some extent limited, yet the uses of compressed air are certainly not few. We use it very successfully with hoists, and we find that in our boiler shops where we could build only three boilers a week without the air for tapping the staybolts and screwing in the staybolts, we can now build four boilers a week by the use of a very few of these air machines. We have also used air for blowing out cylinders and cleaning the castings, and find it very efficient.

There is one thing about the air machine that we have about decided, and that is that any machine with a rotary piston will not last properly. We have tried every one that is in the market and have not found one that will not be more trouble than it is worth. Mr. McConnell told me that he had gotten up a three cylinder air machine weighing 28 pounds, which will develop five horse-power with compressed air. Twenty-eight to thirty pounds is about as much weight as a man can handle in tapping out staybolts and screwing in the bolts, so we are now thinking of getting up a three cylinder piston machine for doing this work and we believe that wherever air is used with a reciprocating piston that it can be used economically. Mr. McConnell further told me that he found that with one of his reciprocating piston machines he could develop power enough to drive a staybolt tap with the exhaust from the rotary machines. It has been confirmed by experience that the rotary is very wasteful.

Mr. J. E. Sague (Schenectady Locomotive Works): We have been using compressed air quite extensively, and in a general way like that spoken of by Mr. Symington. We use it largely for hoists and for that work find it very economical. As almost all our work is paid for on the piece-work plan, we do not find the men using the air hoists to handle parts which can be easily lifted by hand, and no hoists are put up at machines for which the work to be handled is light. We find for much of our work, in which the choice can be made between a rotary air machine and the electric motor, that the electric motor promises better than the rotary, because it gives more power, and does not cost so much to run. The electric motor has one disadvantage, however, which is the increased weight and space occupied.

Mr. E. M. Herr (C. & N. W. Ry.): I shall have to take exception to the last paragraph but one in the paper, in which it is stated that a short line shaft may be used for heavy machinery and all the light machinery may be driven by air. This looks, I take it, to the installation of air motors in machine shops, as many electric motors are being installed in various places throughout the country, and with, as I understand, very good success in economy. I am inclined to doubt very seriously whether the air motor is adapted for this service. I say this because it seems to me that the experience thus far had with air motors shows that they are not nearly as efficient, and I doubt very much whether the outlook ahead would indicate that they can be made nearly as efficient as electric motors as a means of transferring energy from central stations to detached motors.

In France compressed air has been used as a means of transmitting power probably to a greater extent than in any other country. In looking up the matter of experience with the use of compressed air in motors in that country I found some data which throw a little light upon what it costs to run motors which had been developed to a pretty high state of efficiency. In small rotary engines, in Paris, it was found by careful tests (I quote from Kent's Handbook) that as high as 2,330 cubic feet of air per brake horse-power per hour were used. I do not doubt that many machines used to-day in machine shops for the purpose of tapping and drilling holes will show fully as large a consumption of air per horse-power developed in the small motors. In very small motors used for running sewing machines, developing about one-tenth horse-power, the best performance is 1,377 cubic feet of free air per horse-power hour at 384 revolutions. The best performance in a five horse-power rotary engine with air reheated to 356 degrees Fahrenheit, running at 350 revolutions, is 791 cubic feet per horse-power hour. The ordinary practice with high class, well-designed motors shows a consumption of about 1,200 cubic feet free air per horse-power per hour when furnished at 50 to 60 pounds per square inch in pressure. From tests recently made on a high class compressor, with Corliss valve gear and compound air cylinders, with an inter-cooling attachment between the cylinders, I am led to believe that with steam at 80 pounds pressure and the machine running at 75 revolutions per minute it is about all that ought to be expected to get that air for an expenditure of 30 pounds of water per horse power per hour; that is, per horse-power per hour developed in the steam cylinder when we use the air in motors that will give as good an efficiency as 1,200 cubic feet per horse-power per hour.

The efficiency of the transmission from the steam engine to the motor will be about 25 per cent. as it required one horse-power to produce 300 cubic feet of compressed air per hour. This efficiency is of course obtained without heating the air. If air is reheated it is possible perhaps to raise that efficiency as high as 40 per cent. and possibly a little higher than that.

I am very greatly in favor of using compressed air in repair shops; I think it is productive of economy, but it is productive of economy when it is compared with hand labor, and not generally when it is compared with the most efficient means of transmitting energy. I do not believe that it can compare with efficient transmission of electrical energy for use in running line shafting and operating detached machine tools and uses of that kind.

Mr. William Forsyth (C., B. & Q. R. R.): Our compressor consists of a 10 by 48-inch air cylinder attached tandem to one of the cylinders of the shop engine, an 18 by 48-inch double Corliss engine. It is jacketed and cost $300. We have indicated the engine with the air compressor free and also when it was compressing air to 80 pounds and found that it required 40 horse-power. We get a horse-power with the Corliss engine with 4¾ pounds of coal per hour, and the air compressor consumes 204 pounds of coal per hour, and at $3 a ton the cost of 1,000 cubic feet of free air compressed to 80 pounds is 10 cents. With coal at $1.50 per ton it is, of course, only 5 cents per 1,000 cubic feet.

Referring to the paper under discussion, I would also take exception to one of the suggestions in the latter part of the paper relating to the use of compressed air for furnace blast and for forge fires. That is probably the most expensive application of compressed air that I have heard of and it at least costs ten times as much to produce blasts in that way as it would with a fan, and this brings us to the wastefulness of the application of compressed air. I believe that this is the next thing that we must go after and that there is a larger field perhaps in effecting economy in getting efficient tools to use for the application of compressed air than there is in perfecting any further the air compressor. This will be readily appreciated when we remember that if we have an air leak from an 80 pound pressure through a hole one-quarter inch in diameter it will use up more than a 10 horse-power compressor can deliver. Now in going through the shop the other day I noticed that one of the apprentice boys had a hose connected to the air pipe and he was blowing the chips out of the hole he was drilling in cast-iron, and the power used in getting those chips out was a great deal more than would be required to drive the drill press and boy too. And that is only an illustration of the tendency to waste all through the shop. You will find in the summer time that the men have pipes of that kind where they are cooling themselves with an air blast, and the small holes all about the shops, leakages in the pipes, will use up a great many horse-power of compressed air.

Mr. William A. Parker (Ingersoll-Sergeant Drill Company): Compressed air is, as we all know, a power which has only recently been investigated and installed by the railroads. The process of producing compressed air commenced in a very primitive way by the use of the Westinghouse air brake pump, which should have the honor of the introduction of compressed air to railroad uses and shops. From that day we have gone on in the improvement and manufacture of compressors, until we can confidently say that with a four stage compressor, with the Corliss valve gear, compound condensing type, we can produce 1,000 cubic feet of free air compressed to 1,000 pounds for less than 2¼ cents. This is by actual test. There are tests going on to-day in the city of New York with a four-stage compressor which will in a short time be completed, and then we shall have authentic figures for compressing air to 1,000 pounds and over per square inch.

Speaking of the losses in compressed air there is no excuse for a leak in the mains, or through the shops. Where the mains are properly laid and taken care of in the first installation, I have never heard of a leak that has occurred afterward, except as a result of an injury.

The use of compressed air is, I think, in its infancy, and it has only recently claimed the attention of scientific men and mechanical engineers. I think it will from this on progress; as has electricity. I do not think it will take the place of electricity, but as a motive power I think it will fill a long needed want. Compressed air in street car service has not yet been sufficiently advanced, nor have experiments been made to advance any accurate figures or facts, but compressors and compressed air for railroad use and for railroad shops are attracting the most attention to-day. I think we can safely say that with compressors of the straight line type, with the common Meyer valve with adjustable cut-off, that we can produce compressed air, with coal at about $3 per ton or less, for less than four cents for 1,000 cubic feet of free air compressed to 100 pounds. This includes all expenses of operation and interest on investment.

Mr. J. F. Lewis (Rand Drill Company.): There is a great increase of efficiency in reheating the air before it enters the working cylinder. Of course it costs something to do this, but the cost is very small compared with the increased efficiency. This has been demonstrated in using compressed air for street car propulsion. During an experiment, the cars were run about 40,000 miles. The air was carried in storage tanks, at from 600 to 800 pounds pressure, being passed through water heated to 360 degrees to a reducing valve and direct to the working cylinders, where it was used at from 50 to 150 pounds pressure according to the grades or the condition of the track. It was found that the cars could be run 8 to 10 miles when the air was reheated, and only four to five with cold air. This was known as the Mekarski system, which has been used successfully in Nantes for the last eight or nine years, and three years ago three street car lines were established in Paris under the same system

They carry the air at a pressure of between 1,100 and 1,200 pounds, reducing it to the proper pressure when used. We have also made experiments in our shops, which convinced us that it produced much better results by being used hot. In Paris, where air is carried about the city for power purposes by the means known as the Popp system, an efficiency of 92 per cent. is claimed with heated air, as against 70 to 72 per cent. not heated, and it is believed to pay well to reheat.

I have a letter from Mr. George W. Smith, Master Mechanic of the A., T. & S. F. Railway, Topeka, Kan., in which is given data in regard to the cost of compressing air used in the shops at that point, which gives the following:

A., T. & S. F. R. R. COMPRESSOR.

Steam pressure, 80 pounds.
Air pressure, 100 pounds.
Tons of coal of 2,000 pounds per month, 155.
Cost of coal per month, $139.50.
Cost of coal per ton, 90 cents.
Amount of free air per minute, 1,712 cubic feet.
Amount of free air per day of 10 hours, 1,027,584 cubic feet.
Amount of free air per month of 31 days, 31,855,104 cubic feet.
Revolutions per minute, 50.
Pounds of coal per 1,000 feet of free air, 9.7.
Cost per 1,000 feet of free air, .00437 cent.

This compressor is fitted with Meyer adjustable steam valves, compound-air cylinders with mechanical-air valves on the low-pressure cylinders. Air is taken from outside the engine room; The above cost is for fuel only; for the air delivered from the compressor, that is the cost of oil, labor and interest on cost of plant, is not considered. The steam cylinders are 20 inches by 48 inches, air cylinders, 28 inches and 16 inches by 48 inches; horse power, 310.

I will say in connection with this, that there are five miles or over of piping through these shops and yards, in which compressed air is carried to the different tools. As to the saving over the old way, Mr. Smith says:

"With the 10-foot reach, stationary riveting machine we can drive 2,000 rivets per day of ten hours, with three laborers at a total cost of $4.75 per day. This compared with hand labor three men, total $7 per day, will drive 200 rivets. The 6-foot riveter, the combination flange punch and riveting machine and the bridge and girder riveter will each average about the same as the 10-foot reach riveter. The truck riveters; one machine operated by two laborers at a total cost of $3 per day, drive 3,000 rivets in a day of 10 hours, as compared with hand labor, three men at a total of $6 in the same class of work who will only drive 175 rivets. The frame riveter will average about the same as the truck riveter. The staybolt breaker will make an average saving of $8 a day. The tank riveter will make an average saving of $10 a day. The mud ring riveter will drive as many rivets as can be handed to it, and will make a saving of from $12 to $15 a day for that class of work. Not only does it make a great saving, but it insures every rivet hole being entirely filled and insures tight work, while a large per cent. of hand driven rivets in mud rings invariably leak and have to be caulked or fullered. The staybolt cutter will do the work of 15 men; this looks rather fishy, but it is a fact. You have seen this machine work, and it will very easily cut off 1,500 bolts an hour, while when cutting them off by the old method of hand hammer and chisel you must agree that progress is very slow and that it is hard work. The rotary tapping and drilling machine will do the work of six men. The rotary grinder saves the work of six men. The rotary saw for sawing car roofs saves the work of four men. The pneumatic hammer will save the work of three men. A rail saw saves the work of two men. A rail drill saves two men. The device for operating transfer table saves $6 per day. The machine for revolving driving wheels for setting valves saves the labor of two men. The device for shearing bolts saves the labor of three men. Thirty hoists in various parts of shops save the labor of 10 men at $1.50 per day. Apparatus for loading and unloading oil at the storehouse saves $6 per day over the old method. A jack for pulling down car draft sills saves $10 per day. A device for fitting up hose couplings over the old methods saves $15 per day. With the pneumatic painting machine, one man does the work of 10 using hand brushes. The machine for tearing down old car roofs saves $8 per day. A jack for raising and lowering freight and passenger cars makes an average saving of three men. The drop pit makes an average saving of two men. The device for sending engines saves one man. The shifter for switching cars in shop yard saves $50 per week. The coal-cleaning device saves ten men. The flue roller makes a saving of two men over the old method. The white-washing machine will do the work of ten men with brushes."

Mr. J. N. Barr (C., M. & St. P. Ry.): There is no doubt that with the improvement in compression we can get compressed air at very reasonable figures, but what I feel a little doubtful about is the multiplicity of uses to which it is being put and the apparent saving in men. It is true that you can do all these things just as they are shown, but there is a likelihood of extra men being about the work getting it ready and watching it through. There are many cases where it is an absolute impossibility to spare the men that are necessary for initiating some of these operations and unless this matter is watched with an eagle eye, I think that these leaks are going to be a great deal worse than the leaks out in the air pipe and with scattered work such as we have in railroad shops I am perfectly frank to say that I am more afraid of those leaks than I am of the losses of the use of air, and more afraid of losses there than in heating of the air due to compression and the consequent loss. There are cases in which compressed air can be used to good advantage and good results that are unquestioned may be obtained; there are other cases wherein it can be used, but used at a very great disadvantage and in these cases as some of our members have said, it has been found cheaper to throw the devices away entirely.

When compressed air begins to compete with electricity as a rotary agent, I feel inclined to think that it is tackling a problem in which it is coming out second best. We have all heard to-day about the difficulty in the way of making rotary engines. I heard of it when I was a boy. Now, on the contrary, with electricity you cannot get a satisfactory motor except a rotary one. It utilizes the power in the very best and most advantageous way and I think it has its field in that respect and it looks to me now that for rotary motion and continuous work compressed air is going to have a very hard time maintaining itself beside electricity. The development of both at the present time is comparatively new and that opinion may, when you look at it a few years hence, sound like arrant nonsense. However, it remains to be seen.

New Passenger Locomotives for the New York Central and Hudson River Railroad.

The Schenectady Locomotive Works have recently built a lot of eight-wheeled locomotives for the New York Central & Hudson River Railroad Company, from specifications and drawings prepared by Mr. Wm. Buchanan, Superintendent of Motive Power. The boilers of the new engines have a very large heating and grate surface—a very important feature in fast heavy traffic, and one which Mr. Buchanan has always advocated. The driving and truck journals are of very large size, while the driving boxes are of solid Magnus metal. The driving wheels are cast of gun iron. The piston rods are extended through front cylinder heads—a practice which has been found very advantageous by Mr. Buchanan—reducing to a minimum the trouble with wear of cylinders and broken piston rods.

All these engines are in fast service on the celebrated "Empire State Express," the Fast Mail, and the Chicago, St. Louis & Cincinnati Limited trains, and have already made some exceptionally fast time on these trains.

On Dec. 1, one of the engines, No. 924, made the run with train No. 50—the "Empire State Express," east—from Syracuse to Albany, a distance of 147.84 miles, in two hours and thirty minutes, including a three-minute stop at Utica, together with a slow-down going through Schenectady and a slow-down going the streets of Syracuse, a distance of about one and one-half miles, in compliance with that city's ordinance limiting the speed to eight miles per hour. Deducting ten minutes for the time in running the one and one-half miles in Syracuse and three minutes' stop at Utica, leaves the running time from the city limit of Syracuse to Albany, two hours and seventeen minutes. Deducting the one and one-half miles in Syracuse from the total distance leaves 146.34 miles, which made a speed of 64 miles per hour for the 146.34 miles, not allowing for slow-down through Schenectady.

There were ten engines in the above lot, five of which had drivers 78 inches, while the other five have drivers 70 inches diameter. From the specifications we take the following:

GENERAL DIMENSIONS.

Weight in working order	136,000 pounds
" on drivers	90,000 pounds
Wheel base, driving	8 feet 6 inches
" " total	23 feet 11 inches
Cylinders	19 by 24 inches
Piston rod packing	U. S. metallic
Kind of slide valves	Richardson balanced
Kind of valve stem packing	U. S. metallic
Diameter of driving wheels outside of tire	78 inches
Tires	(Midvale steel) held by shrinkage and retaining rings
Driving box material	Magnus metal
Diameter and length of driving journals	9 inches diameter by 12½ inches
Diameter of engine truck wheels	36 inches
Kind " " " "	Krupp No. 3
Style of boiler	Wagon top
Outside diameter of first ring	(Smoke-box jacketed) 60 inches
Working pressure	190 pounds
Mat'l of barrel and outside of firebox	Carbon steel
Firebox	108⅛ inches by 40⅞ inches
Firebox material	Carbon steel
" staybolts	Brown & Co.'s U. S. iron, ⅞ inch and 1 inch diameter
Tubes, material	Syracuse S. L. W. charcoal iron, No. 11 W. G.
" number and size of	288, 2 inches, O. D. by 12 feet 1⅛ inches long
Heating surface, tubes	1,809.56 square feet
" " water tubes	12.93 square feet
" " firebox	158.23 square feet
" " total	1,980.72 square feet
Grate "	30.69 square feet
Boiler supplied by	Two Monitor injectors, No. 10 R. S., No. 9 L. S.
Tender frame	6⅛ inches by 4 inches by ¾ inch angle iron
Water capacity of tank	4,500 United States gallons
Coal capacity	8⅛ tons

The engine is equipped with a double-riveted mud ring, two 3-inch Consolidated muffled safety valves, Westinghouse automatic air-brake on drivers, tender and for train, Westinghouse air signal, 9½-inch air pump, asbestos cement boiler lagging, Gould pilot and long shank tender coupler, water scoop on tender, piston rods extended through front cylinder heads, Nathan No. 9 triple-sight feed lubricator, springs made by Schenectady Locomotive Works, star round case headlight, American steel brakebeams on tender, and Ross-Meehan shoes.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE,
MORSE BUILDING..NEW YORK

M. N. FORNEY, W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

FEBRUARY, 1897.

Subscription.—$2.00 *a year for the United States and Canada;* $2.50 *a year to Foreign Countries embraced in the Universal Postal Union.*

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

There are few men who in the conduct of their business are so matter of fact and so far removed from the charge of being sensational as is Mr. G. W. Rhodes. But whether he intended it or not he created somewhat of a sensation when he announced as the subject of his paper before the Western Railway Club "Has the Air-brake a New Enemy?" Curiosity, which was greatly aroused, has now been satisfied by the appearance of the paper, and it exposes the enemy in the form of a wasp, whose habitat is the plains of Nebraska, that has developed a fondness for railroad travel. It enters the shell of the retaining valve and there perfects certain incubating arrangements that interfere somewhat with the operation of the valve. The proposed remedy is to make the opening in the case a narrow slit, instead of a round hole as at present, thus compelling this intelligent insect to seek a new resting-place when traveling on freight trains.

A hasty reading of the discussion on compressed air by members of the Western Railway Club, an abstract of which we publish on another page, may lead some to think that the general trend of the remarks was against the use of this valued agent. A more careful reading will show that the speakers were not opposed to it, but that they realized the limitations of compressed air, and were disposed to believe that the application of it had been overdone in some cases. Those who hold this view are in reality the best friends of compressed air. With so many possible uses in which economy will result, it would be a pity to bring compressed air into disrepute through unwise applications of it. At the same time it must not be forgotten that with a compressed air plant once installed there are services to which one is justified in applying it, even if its economy would be somewhat less than that of an electric motor, because of the smaller investment necessary or the convenience in the generation of power, or the fact that an electric power plant is not already in operation daily. But compressed air has its limitations, and they should be recognized.

Notwithstanding the large area of the heating surfaces provided in the modern locomotive, it still remains true that the limit to a powerful locomotive's work is always its boiler power. It would not be improper to state that in considering an increase of boiler power, the augmented heating surfaces are more difficult to provide for than is the enlarged grate area; we can get the grate area somehow, but to get the heating surfaces without exceeding that other limiting condition, a given weight, seems at times next to impossible. And yet the larger grate area is of little value without a corresponding increase in the heating surface, a statement which seems to be supported by the changes now being made in a famous engine that went into service on a Western road some time ago, and whose ratio between grate and heating surface was about forty to one. In view of the difficulty of getting more than 2,200 square feet of heating surface in even the largest and heaviest of modern passenger locomotives, it is of interest to know that a builder has recently been asked by a well-known superintendent of motive power to lay out a design for a passenger engine in which nothing less than three thousand (3,000) square feet of heating surface will be provided. This is virtually 50 per cent. more heating surface than obtained in the engines of to-day, for those that exceed 2,000 square feet are so few in number that they may be considered as exceptions to the rule. If such an engine is produced it is not exaggeration to say that it will mark an era in locomotive design and construction.

THE COST OF ARMOR PLATE.

Elsewhere in this issue will be found a brief summary of the report of Secretary Herbert on the cost of armor plate. The result of his investigation is a recommendation that the armor plate for the three battleships authorized be contracted for at not more than $400 per ton, and that if three more battleships are authorized their armor should be furnished at not more than $375 per ton; and furthermore, that if the two armor-making concerns in this country will not come to these terms, the government buy a plant or construct one of its own. The actual cost of labor and material, exclusive of nickel, is placed at $196.40, and the price suggested, $400 per ton, is claimed to cover fixed charges and give a profit of 50 per cent. Senator Chandler has also made a report on armor to the Senate Sub-Committee on Naval Affairs, in which he recommends a price of $300 per ton, which, he says, gives the makers 33 per cent. profit. He leaves the question of constructing a government armor plant to Congress, but, like Secretary Herbert, places the cost of such a plant at $1,500,000. The attacks on invested capital in this country are so numerous that many of our readers will probably hear frequent charges of selfishness, exorbitant prices and excessive profits made against the companies who have been instrumental in bringing our armor plate up to its present standard. We have no desire to defend the policy of any company that is seeking more than its due, but whatever course is decided upon for the future in letting contracts for armor, the conditions under which the two plants in this county were established should not be forgotten. The Bethlehem Iron Company established the first one, and it is admitted that it cost at least $4,000,000, while some experts place the cost at nearer $5,000,000. The investment of so much capital in a plant of this kind, with the prospect of its continuous employment depending entirely upon the course of Congress, which might at any time change or modify its policy of naval construction, is no mean undertaking, and in view of the

uncertainty of the market for armor it is but natural that the company should expect to have the cost of the plant returned to it in profits in a comparatively short time. That the first plant cost over $4,000,000, that the next one was built for not more than $3,000,000, and that at present a complete plant can be constructed for $1,500,000, is only another proof of the risk of capital in the first undertaking. Furthermore, the advances in armor construction have nowhere been as great as in the United States, and this country now leads the world in this particular. It is quite certain that if the government had begun armor construction with its own plant it would not, up to date, have saved money, and it is equally certain that it would not now be turning out armor as good as it can buy. If the expensive plants which these armor-making concerns erected some years ago have in reality been nearly paid for out of the profits of the business, a reduction of present prices ought to be expected. But the determination of a future policy ought not to be affected by a mistaken belief that the government has been unjustly dealt with in the past, for it has not been so treated when the output of armor has been of honest quality and as good as the manufacturer was at the time capable of producing.

GOVERNMENT INSPECTION OF STEEL.

The investigation into the qualities of the steel plates furnished for the hulls of the battleships *Kearsarge* and *Kentucky* by the Carnegie works has resulted in a voluminous report from the special board of inquiry to Secretary Herbert. The report has not been made public, but it is learned that the steel is satisfactory when tested lengthwise, but does not meet requirements when tested crosswise. The Secretary has directed that the constructor at Newport News (where the ships are being built) may use such plates as will prove satisfactory in view of their position in the ship, each plate to be accepted or rejected after an individual test. Commodore Hichborn, chief of the Bureau of Construction, in forwarding the report of the special board, says in part:

"An examination of the sheet giving the results of tests submitted by the board shows that as regards tensile strength and elongation the metal complies very well with the specifications, the average tensile strength being in the neighborhood of 65,000 pounds, and but two specimens taken from the same plate falling appreciably below the elongation required of 25 per cent. The variations in tensile strength between the longitudinal and transverse specimens are slight and irregular. The average elongation of the longitudinal specimens is 27.7 per cent. and that of the transverse specimens 26.2 per cent. The failures which occurred were in the cold bending and quenching tests, and it is only under these tests that there appears to be any marked difference in the behavior of the transverse and longitudinal specimens—the transverse specimens, as might be expected, showing greater tendency to brittleness."

The cause of the trouble is considered by the board to be the lesser amount of work expended upon the plates in crosswise rolling than in lengthwise rolling, and the defect was not detected because the specifications do not require bending specimens to be taken crosswise of the plates. Irrespective of how much there is in this explanation, it is well known in many quarters that the inspection of steel for the government has for years been carried on in a disgraceful and incompetent manner. The line officers have had control of this work, and the engineer officers, representing the Construction and Steam Engineering bureaus have been in the minority on the steel board and in the force of inspectors. Much of the inspection work has been assigned to men who were not competent for these duties, with the result that the quality of government materials has depended more upon the honesty and ability of the contractors than upon the safeguards of competent inspection. It is gratifying to learn, therefore, that the present detection of inferior materials promises to lead to reforms in the steel board and the corps of inspectors. The steel board in charge of the inspection of all steel furnished for new naval construction has already been reorganized, so that its control is now in the hands of the Construction and Engineering Departments, instead of line officers. Furthermore, it has been announced that the work of inspection will be taken from young line officers who have been stationed at the mills and civilian inspectors employed for that purpose. That is gratifying news, and if it is in truth the opening wedge of reform by which line officers will be made to keep to their legitimate duties, and give engineer officers the opportunity to handle untrammeled the business of their departments, the immediate cost to the government from the delay and the re-inspection of the plates for these ships will be money well spent. In January, 1896, the steel board consisted of two line officers and one engineer officer, and the inspection of steel and armor was performed by six line officers, two engineers, one carpenter and two sailmakers.* So that out of a total of 20 officials concerned in the inspection of steel, there were three engineers, or the same representation as is given the carpenters and sailmakers. During the year the criticisms to which the line officers were subjected compelled them to alter the personnel of the inspectors somewhat, but they still kept their grasp on the steel inspection. Now it seems that this exposure of their methods has compelled them to turn over the inspection to the officers to whom it rightly belongs. It is said that the new board will at once take up the work of revising the specifications for steel.

AMERICAN MACHINE TOOLS ABROAD.

An exhibit of admirable cycle-making tools by the Pratt & Whitney Company, of Hartford, at a recent cycle show in England, is the occasion of an editorial in *Engineering*, in which the superiority of American tools of this kind are plainly set forth. After stating that the special tools in use by cycle manufacturers in England have in the main been devised in their own shops and are not to be bought in the market, our contemporary says:

"The American makers have stepped in and are at the present time reaping a rich harvest in selling, pretty well at their own prices, special cycle-making machinery of a nature which cannot be purchased from British manufacturers. The fact is the more annoying because there is nothing in these tools which our native mechanics could not have produced if they had only thought—but then, thinking is the hardest work a mechanic does. We recognize the ingenuity of these American machines, the skillful way in which they are devised to get over difficulties and to produce mechanically the maximum result—both in quantity and quality—with the least amount of costly human intervention. The candid Englishman must admire these things, but he is apt to attribute them wholly to the natural mechanical genius of the American—something natural to the soil, which he summarizes as 'Yankee ingenuity.' Now if in anything genius may be rightly described as 'an infinite capacity for taking pains,' it certainly is so in regard to mechanical design. All these beautiful devices we see in the Pratt and Whitney machines did not flash into the brains of their originators during idle moments like lightning in a summer sky; but, however suddenly the end may have come, they were the results of previous study of what was required, and careful thought as to the best way of producing it. And if this is true of the individual, it is equally so of the corporation or firm to which he belongs. . . . It is hard to account for this higher perfection of light machine tool making on the other side of the Atlantic. We are apt to consider in a new country things are inclined to be hap-hazard and makeshift, but we must not forget that the engineering history of New England extends almost as far back as that of Old England. At any rate the first American designers had all the benefit of our early experience; for come what may, nothing can rob England of the honor of being the birth-place and nursery of modern mechanical engineering."

Our contemporary then offers as one explanation of the superiority of American tools the fact that in England machine tool builders, who were brought up in the shops, are being superseded by their sons, educated in schools where the spirit of mechanical ingenuity is unknown and whose only knowledge of the shops has been obtained by remaining in them long enough to get "a fair knowledge of the work." Another class equally unfitted to lead in machine design is described as the builders who began life as mechanics, and have prospered by dint of frugality until they own works of their own, but whose mental horizon is narrow. Turning to the conditions in this country, our contemporary says:

"The New England mechanic is, however, a different man to his confrere in this country. Whatever may be said about 'there

* See AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL for November, 1896, page 298.

being no more equality in a republic than under a monarchy,' and of the 'aristocracy of the almighty dollar,' or of 'class distinction being as closely marked in America as in England,' there is no doubt that the New England mechanic holds himself more the equal of his employer than does the English craftsman; and, further, that the employer recognizes this claim. The fact has nothing to do with the form of government; in our opinion the root of this healthy feeling is in the method of education, under which the sons of masters and men sit on the same form at school. The influence is good for all; it levels up both classes.

"In regard to the engineering industry, and the machine tool trade in particular, the results have been most fortunate. The sons of employers have entered upon their career with a truer appreciation of the work of the artisan, and the value of shop practice, on which the success of the business must, after all, so largely depend On the other hand, the young artisan sees that his employers are not a race apart, but have characteristics in common with himself, so that it only needs a change of environment to enable him to take his place among them.

"It may be said this is more a social problem than one having any bearing on the machine tool industry. We think otherwise. The nearer approach to social equality between employer and employed—the executive, the drawing office and the bench—leads to a unity which is strength. The American workman speaks out more boldly, he ventures to differ more emphatically, or rather he differs without the thought that he is venturing, and holds his point firmly. On the other hand, the employer is not afraid to discuss matters with his workmen; he does not feel he loses caste by arguing the matter out, even if he got beaten in the argument. In fact, the two classes meet on an equality which is necessary to perfect council."

In placing so much importance upon the better relations existing between employer and employee in this country. *Engineering* has undoubtedly directed attention to one of the greatest factors in the successes of American tool builders, and we doubt if in any shops the relations are more cordial than in those of the establishment whose excellent tools called forth our contemporary's editorial. The difference between designing carried on by a small corps of men standing alone, and designing which in the long run represents the best thoughts of every brainy man in the establishment, must be great. If any other reason for the present superiority of American machine tools is needed, it can be found in the higher wages paid in this country, the higher plane which a mechanic is thus enabled to occupy, and the incentive thus given to save in the cost of labor by making each hour of labor more productive. This incentive is much greater here than it is abroad. It is so great that it is felt by men of all grades in our engineering and manufacturing establishments, and so we find a large portion of these well-paid employees heartily co-operating with their employers in the improvement of machinery for making labor more productive or doing away with it altogether in certain operations. May the good wages prevalent in this country and the better standing of the employed never decline, but be ever on the increase.

NOTES.

At a meeting of the Engineers' Club of St. Louis, on January 6, 1897, a paper was read by Mr. F. F. Harrington on "a new testing machine and the cross-breaking test of vitrified brick." The machine was described, and the methods of calibrating it and determining its friction were explained. A number of tests of vitrified paving brick were given and broken specimens were exhibited. In conclusion, standard methods for making the cross-breaking test of vitrified brick were proposed.

Press dispatches of January 20 state that another naval engineer has succumbed to overwork on board our vessels of war. This time it is Fleet Engineer Bumap of the *Olympia*, the flagship of the Asiatic squadron. He is a veteran of the civil war and is closely approaching the compulsory naval age of retirement. He has collapsed under the strain of looking out for the 17,000 horse-power machinery of the *Olympia*, while at the same time exercising the general duties of Fleet Engineer of the squadron.

Chair car No. 1,432, on the Sante Fe route, is equipped with the new system of electric lighting, the current being generated from the car axle. This car made about 2,400 miles in local service and was then put on trains Nos. 5 and 6 in the Chicago-Denver service. On the first trip it ran through a heavy rainstorm, followed by freezing weather and a snow storm in the West. Notwithstanding this, it completed its first round trip of 2,418 miles. It is now running regularly in this service. The Chicago, Burlington & Quincy Railroad has had two experts on this car ever since it began running to Denver. When the train is running, the light is taken direct from the dynamo, and when running at less speed than eight miles per hour, or standing still, it is taken automatically from the storage batteries.

A novel method of compressing air is employed by the Taylor Hydraulic Air Compressing Company, of Canada. A falling column of water is made to entrain air which is compressed by the weight of the surrounding water and when the water reaches the lower level it enters an air chamber where the air separates from it and is stored above it ready for use just as steam occupies the steam space of a boiler. A 150 horse-power installation on this principle has been put in for the Dominion Cotton Mills at Magog, near Montreal. It has been operating since last September without a hitch. The beauty of the thing lies in the fact that there is no moving machinery in the air compressing outfit—only a column of falling water.

Our readers will remember that in 1892 the Illinois Central Railroad investigated the desirability of using electricity in its suburban service and for handling the World's Fair traffic on its suburban tracks. In a recent discussion on electric traction before the Western Society of Engineers, Mr. H. W. Parkhurst presented the estimates made at that time. They are now, of course, five years out of date, so to speak, but they are not without interest. The estimates include power plant, line, motors and cars, but not track. The first estimate is for handling 12,000 passengers per hour in four-car trains at a speed of 20 miles per hour over a track 7½ miles long, with the trains running around loops at each terminal. The capital expenditure would have been $812,000 and the daily operating expenses $750.40. The next estimate is on the same basis, except that 18,000 passengers were to be handled per hour. The capital invested would have had to be $1,220,900 and the daily running expenses $1,095.10. For 24,000 passengers per hour the figures would have been $1,624,200 and $1,456.95 respectively. The fourth estimate was based on carrying passengers at the rate of 12,000 per hour from 6 a. m. to 3 p. m. and between 7 and 12 p. m., at the rate of 18,000 per hour from 3 to 5 p. m. and 24,000 per hour from 5 to 7 p. m. The capital expenditure was put at $1,564,200 and the daily expenses $1,105.60. Then follows a comparative statement of steam and electric power for handling the regular suburban service, in which it is shown that electricity would require an expenditure of $1,847,500 in capital as against $1,584,000 for steam. On the other hand, the daily operating expenses for electricity are put at $1,813.75 and for steam $2,032.46. It should be stated that the operating expenses include interest and maintenance in each case. Those who desire to see the figures in greater detal can find them in the journal of the society for December, 1896.

In his recent annual report, Commodore Melville says, regarding the new cylindrical boilers for the *Chicago*: "The completion of the boilers has been delayed owing to failure to obtain the nickel-steel plates originally ordered, and to further delays consequent on the failure of the manufacturers to deliver within reasonable time enough shell plates of nickel steel of a satisfactory finish to complete one of the cylindrical boilers. The working of the nickel steel plate finally accepted for one boiler has also involved some delay, and the experiment, as a whole, has added considerably to the cost of manufacture of the cylindrical boilers." The Secretary of the Navy in his report refers to the same subject in these words: "When the cylindrical boilers for the *Chicago* were being designed, the Department sanctioned the use of nickel steel for the shell plates, but the plates received from the contractors were of such a character that grave doubts existed as to whether they could be used, on account of uneven surfaces. The manufacturers experienced such difficulty in getting satisfactory plates that the Department eventually decided to build but one of these boilers of this material, and to construct the others of the ordinary carbon steel. The physical tests of the nickel-steel plates were all that could be desired, and it is confidently anticipated that the makers will eventually overcome the difficulty that has been experienced in making smooth surfaces. When this is done, a material reduction in the thickness of boiler plates will be practicable."

Personals.

Mr. Ed. D. Robbins, of Hartford, Conn., has been chosen Vice-President of the New England Railroad.

Mr. Eugene S. McCarty, General Manager of the St. Louis, Cape Girardeau & Fort Smith, has resigned.

Mr. E. M. Poston, of Nelsonville, O., has been appointed Receiver of the Columbus, Sandusky & Hocking.

Mr. B. F. Johnson has been chosen President of the Chicago, Paducah & Memphis, vice Mr. W. L. Huse, resigned.

Mr. Morgan Jones, previously General Manager, has been elected President of the Fort Worth & Denver City.

Mr. William V. Reynolds, Receiver of the Lebanon Springs Railroad, died suddenly in New York City last month.

Mr. F. F. Lyons has been appointed Chief Engineer of the East Broad Top Railroad, with headquarters at Rockhill Furnace Pa.

Mr. S. Wesselius, of Grand Rapids, Mich., has been appointed Railroad Commissioner of Michigan, to succeed Mr. S. R. Billings.

Mr. John A. Graves has been appointed Purchasing Agent of the Hutchison & Southern, with headquarters at Hutchinson, Kan.

Mr. W. E. Sells, of New York, has been chosen Vice-President of the Chesapeake & Western, with office at 30 Broad street, New York.

Colonel Ashley W. Cole, has been appointed a State Railroad Commissioner of New York, to succeed Samuel A. Beardsley, resigned.

Mr. Charles D. Owens, Vice-President and General Manager of the Atlantic & Danville Railway, died suddenly, Jan. 15, at Norfolk, Va.

Mr. H. K. Gilbert, until Jan. 1, Auditor of the Crane Company, of Chicago, has been elected Treasurer of the Sargent Company Chicago.

Mr. E. W. Knapp has resigned as Master Mechanic of the Mexican National to accept a similar position on the Interoceanic-Puebla Railway.

Mr. J. N. Beckley, of Rochester, N. Y., Vice-President of the Toronto, Hamilton & Buffalo Ry., has been chosen President, vice Mr. S. E. Peabody.

Mr. Wm. P. Ijams has resigned as President of the Belt Railroad & Stock Yards Company, Indianapolis, Ind., and Mr. D. F. Kinshall succeeds him.

Mr. George Dullnig has been appointed Receiver and General Manager of the San Antonio & Gulf Shore road, in Texas, in place of Mr. Henry Terrall.

Mr. John F. Barnard, of Omaha, Neb., Receiver of the Omaha & St. Louis, has also been appointed Receiver of the St. Clair, Madison & St. Louis Belt Line.

Mr. G. A. Woodman, late of the Illinois Central, has been appointed Superintendent of the car department of the Lima Locomotive and Machine Company, Lima, O.

Mr. H. C. Frick, of the H. C. Frick Coke Company, has been elected President of the Youghiogheny Northern and the Mount Pleasant & Latrobe railroads in Pennsylvania.

Mr. Albert M. King, who has filled the position of General Superintendent of the Jackson & Sharp Company's Works for 18 years, died suddenly on New Year's night, of heart disease, age 48 years.

Mr. H. C. Smith, Master Mechanic on the Delaware & Hudson, at Oneonta, N. Y., has resigned, and Mr. J. R. Skinner, Master Car Builder at the same place, has been put in charge of both departments.

Mr. George A. Hancock has resigned as Superintendent of Machinery of the Gulf, Colorado & Santa Fe to take the position of Assistant Superintendent of machinery of the Atchison, Topeka & Santa Fe, with headquarters at Topeka.

Mr. Myron T. Herrick, of Cleveland, and Mr. Robert Blickensderfer, of Toledo, were last week appointed Receivers of the Wheeling & Lake Erie road. Mr. Blickensderfer is the General Superintendent of the Wheeling & Lake Erie.

Mr. William Smith, formerly Superintendent of Motive Power and Machinery of the Chicago & Northwestern, has been appointed Master Mechanic of the Duluth, Missabe & Northern, a position heretofore held by Mr. A. F. Priest.

At a meeting of the directors of the New York, New Haven & Hartford Railroad, Jan. 11, the position of Third Vice-President was formally declared abolished, and Collin M. Ingersoll was appointed assistant to the President, with office at Park Square Station, Boston.

Mr. W. H. Fry died in St. Louis last month. Mr. Fry was for several years Superintendent of the car department of the N. Y., N. H. & H. R. R., but was better known through his service with the Pullman Palace Car Company, with which he had been connected before going to New Haven.

Mr. W. H. Bancroft, General Superintendent of the Mountain Division of the Union Pacific, has become General Manager of the Oregon Short Line & Utah Northern, which was sold under foreclosure Jan. 9, and which will hereafter be operated with an independent management.

Mr. Charles M. Heald, Receiver and General Manager of the Detroit, Lansing & Northern, has been chosen President of the reorganized company, which is to be known as the Detroit, Grand Rapids & Western. Mr. E. V. R. Thayer has been chosen Vice-President and Mr. Charles Merriam Secretary and Treasurer.

Mr. H. Monkhouse has been appointed Superintendent of Machinery of the Chicago & Alton, with headquarters at Bloomington, Ill., in place of Mr. Jacob Johann, resigned. Mr. Monkhouse has been with the Chicago, Rock Island & Pacific since October, 1889, and since June, 1891, has been Assistant Superintendent of Motive Power of the road.

Mr. W. R. Stirling, who resigned the position of First Vice-President of the Illinois Steel Company last spring, in order to take charge of the affairs of the Universal Construction Company has now resigned the Presidency of that company, intending to associate himself with another line of business. Before doing so, however, Mr. Stirling intends to make a long-expected trip to Europe.

Mr. H. B. Hodges has been appointed Purchasing Agent of the Long Island Railroad in place of Mr. Geo. L. Hubbell, resigned. Mr. Hodges will also have the additional duties and title of Superintendent of Tests, and will arrange for and have general supervision of the inspection and testing of supplies purchased, as well as of tests in actual service, and will issue specifications covering the material to be inspected.

Sir Joseph Hickson, formerly General Manager of the Grand Trunk, died at Montreal, Que., Jan. 4, aged 66 years. He entered railway service in England, and came to America in 1862, taking a position with the Grand Trunk as Chief Accountant. Four years later he was chosen Secretary and Treasurer, which position he held until he was appointed General Manager in 1874. He resigned the latter position Jan. 1, 1891.

Mr. F. L. Wauklyn, Works Manager in the Grand Trunk Railway shops at Montreal, has resigned that position after fifteen years in the service of that company, during thirteen and a half of which he has been the manager of the shops. Mr. Wauklyn has accepted the position of Manager of the Toronto Railway Company, which has some eighty miles of electric railway running in and around the city of Toronto.

Mr. Jacob Johann, Superintendent of Machinery of the Chicago & Alton Railroad, has resigned. Mr. Johann has completed one-half of a century of service in locomotive and car work, from 1847 to 1897, and after this long period of activity he retires to his home in Springfield, Ill., where he will always be glad to receive and entertain his friends. May he long be spared to meet those friends and the many railroad men who honor him for his ability and personal qualities.

The following changes in the mechanical department of the Grand Trunk took effect Jan. 1: Eastern and Northern divisions—Mr. Frank Joy is appointed Assistant Master Mechanic, Gorham, N. H., vice Mr. R. Patterson, transferred; Mr. W. Ball, Foreman, Belleville, Ont., vice Mr. W. D. Robb, promoted; Mr. W. Price, Locomotive Foreman, Toronto, Ont.; Mr. J. McGrath, Foreman Repair Shop, Toronto, Ont., vice Mr. W. Ball, transferred; Mr. Bryce Stimson, Foreman, Gravenhurst, Ont., vice Mr. W. S. Price, transferred. Western Division—Mr. Robert Patterson is appointed General Foreman, Fort Gratiot, Mich., vice Mr. S. Hayward, transferred; Mr. S. Hayward, Locomotive and Tunnel Foreman, Port Huron, Mich., vice Mr. Frank Joy, promoted. Mr. W. D. Robb is appointed Master Mechanic on the Middle Division, with headquarters at London, Ont., vice Mr. A. H. Smith, resigned.

New Publications.

PROCEEDINGS OF THE TWENTY-SEVENTH ANNUAL CONVENTION OF THE MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION. held at New York, September 9, 10 and 11, 1896. Published for the association by the *Railroad Car Journal*, New York. Pages, 118; 6 by 9 inches.

This publication appears in its usual form and contains reports and discussions on subjects of value to every railroad master painter. Among the important subjects treated in this report are the use of compressed air in burning off cars, the flatting of varnish on cars and locomotives, the advisability of painting locomotive jackets: painting galvanized iron, the "enamel process" of painting coaches, painting of a locomotive, painting hot surfaces of locomotives such as dome casings, boiler fronts, etc., the housing of passenger cars, spontaneous combustion in the paint shop, etc., etc. This array of practical subjects are sufficient to indicate the value of the proceedings to others besides the members of the association.

TABLES SHOWING LOSS OF HEAD DUE TO FRICTION OF WATER IN PIPES. By Edward B. Weston, C. E. D. Van Nostrand Company, New York. 170 pages 4¼ inches by 6¾ inches. $1.50.

The tables in this book are the result of 20 years of experience and investigation by the author. Finding hydraulic formulæ unfavorably criticised, the author endeavored to prove then to his own satisfaction and collected data from 520 experiments. A study of this data convinced the author that the same formula would not apply in all cases and that the data should be divided into three classes, one embracing smooth-bore pipes such as brass and lead, another in which the bore was as smooth as new cast-iron pipes, while the third embraced pipes whose surfaces were in the condition of old cast-iron pipe whose interior was roughened by corrosion. The result of his work was a new formula by the author for smooth pipe, and the acceptance of the formulæ of a French engineer, the late Henry Darcy, as suitable for new cast-iron pipe. A general formula for old cast-iron pipes was not found, but the author gives a series of multipliers to be used in connection with the tables for new cast-iron pipes which will give good approximate results. The two formulæ have been tested and tried and their accuracy established, and upon these the tables in the book are based. The tables for smooth pipe embrace diameters from ¼ inch to 3 inches, and those for cast-iron pipe from 4 to 60 inches. Each table has six columns, the first giving the mean velocity of water in feet per second; the second gives the head in feet required to produce this velocity; third, discharge in U. S. gallons per minute; fourth, the loss of head in feed due to friction per 100 feet; fifth, the discharge in U. S. gallons per 24 hours; sixth, the loss of head in feet due to the orifice of influx.

The tables are very complete, the advance from one rate of flow to another being in small increments. The tables are also fully explained and examples of their application given, so that nothing appears to have been omitted that would make the tables valuable to those interested in hydraulics.

A PRIMER OF THE CALCULUS. By E. Sherman Gould, M. Am. Soc. C. E. Van Nostrand Science Series, No. 112. D. Van Nostrand Company, New York.

The word "calculus" in the title of this little book may lead many to decide without further consideration that it is too deep for them. We think, however, that such a conclusion would be too hasty, for the author has dealt with the subject in a brief, simple and effective manner. Furthermore, he confines the work to the rudiments of the science, and anyone willing to make a reasonable effort to obtain a working knowledge of calculus can do so by a study of this book. The author has little to say about the theory of calculus and that little is said after after the reader has gained confidence in the value of the science through an insight into the results obtained from actual work. We advise anyone desiring to take up the study of calculus to study this book.

PROCEEDINGS OF THE FOURTH ANNUAL CONVENTION OF THE NATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION, 1896. 154 pages; 6 inches by 9 inches.

The convention of this society was held in Chicago Sept. 1, 2 and 3, 1896, and a vigorous discussion took place on the papers presented. The papers deal with many subjects of interest to the railroad master blacksmith, such as forges and tuyeres, making of axles, making and repairing locomotive springs, designs of furnaces, making and repairing locomotive frames, gas furnaces, tool steel, etc. In these days so much more attention is being given to railroad blacksmithing that this volume should be of value to every master blacksmith and to some of their superior officers also. It is well gotten up, but a good index to its contents is needed.

Books Received.

YEAR BOOK OF THE U. S. DEPARTMENT OF AGRICULTURE FOR 1895. Washington: Government Printing Office. 1896. 656 pages.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

MILLING MACHINES. The Cincinnati Milling Machine Company, Cincinnati, O., December, 1896. 48 pages, 6 by 9 inches. (Standard size.)

For many years this well-known firm has made the manufacture of milling machines an exclusive specialty, and it has been its constant purpose to make its machines excel in their particular line. The catalogue before us illustrates the latest and most improved designs by this company. The first 20 pages are devoted to plain and universal milling machines of various sizes. In each design the column, knee, saddle, table, overhanging arm (with which each is provided), spindle and bearings, are all of great strength and ample proportions for heavy work. In spindle power and strength of feed it is claimed that these machines are unexcelled. The column has a cylindrical brace between the two supports for the overhanging arm, so that the latter is held in what is virtually one long bearing, the metal in which gives great rigidity to the upper part of the machine. Braces are also furnished between the overhanging arm and knee and permit of heavy cutting. All the feeds and adjustments are convenient to the operator. Ball bearings are used on the table feed screw of the No. 3 machine, thus greatly reducing the friction.

The table is provided with a quick return, handles at both ends, and, in fact, nothing seems to be omitted that would add to the convenience or speed of manipulation. The overhanging arm has an adjustable bronze bushing, split in three places and fitted to a taper hole so that all wear can be taken up concentrically. In the universal machines a distinctive feature is the swiveling carriage for the table. This not only adds to the appearance, but is of especial practical value when cutting spirals or any work requiring the setting of the table at an angle. The swiveling carriage need not be drawn out from the face of the column to the same extent as when made square, permitting at the same time the use of a shorter cutter arbor. Again, the swiveling carriage always has a large bearing on slide on top of knee, no matter at what angle the table is set. This permits further a most effective method for clamping the swiveling carriage to slide on knee. These points all add to

the rigidity of the machine. The index for angles or spirals is placed on the outside of the circular carriage where it may be conveniently read. The graduations, being indexed on a circle of large diameter, insure the greatest accuracy. The table may be completely revolved through 360 degrees, and this same feature allows spirals to be cut beyond 45 degrees. It is provided with oil channels and pockets at both ends.

Among the attachments for milling machines illustrated, is a compact universal indexing and dividing head of excellent design, plain indexing centers, rack cutting attachments, an attachment for securing high speed for light milling work, a vertical spindle milling attachment, cam cutting mechanism, a rotary milling table, vises, arbors and milling dogs. This latter is of a form that prevents the inaccuracies that arise in taper work from the gaining and losing of spacing due to the bent tail of the ordinary dog. An illustration of a universal cutter and tool grinder completes the line of machines presented.

The presswork, engraving and paper are beyond criticism, and the whole forms a very neat and artistic piece of catalogue work.

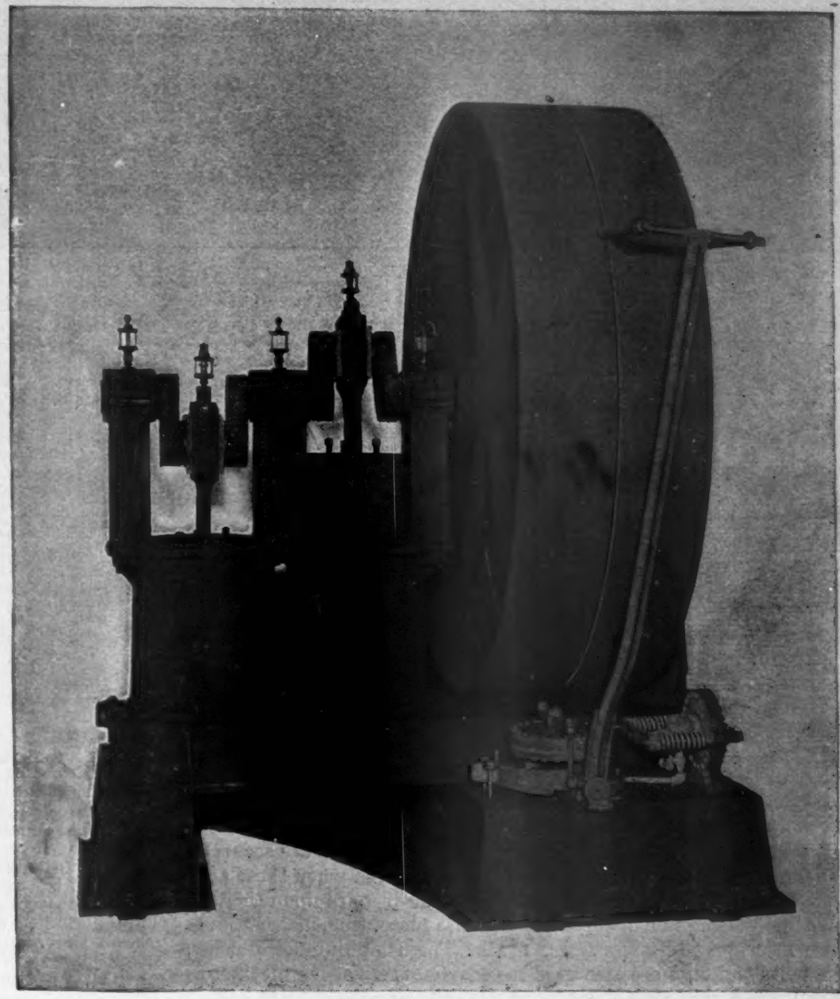
DIXON'S GRAPHITE PRODUCTIONS. Joseph Dixon Crucible Company, Jersey City, N. J., 56 pages, 6 inches by 9 inches. (Standard size.)

This interesting catalogue comes in a bright cover, made so by highly colored views of the company's works at Jersey City, its graphite mills at Ticonderoga, N. Y., and its cedar mills at Crystal River, Florida. Among the graphite productions which are described in its pages is lubricating graphite. The heavy and high speed machinery of modern times has made the question of lubrication an important one. Our readers hardly need to be told that pure flake graphite has proved one of the most satisfactory of lubricants under these modern conditions. For engine cylinders it can be used dry or mixed with a little water or oil. As a remedy for heated bearings it is a great success. In locomotive works it has made an excellent record—in the cylinders, steam chests, air pumps, on bearings, crank pins, etc. The company also make "graphited lubricants," the basis of which is pure flake graphite, and to which is added a good grease that serves the purpose of holding the graphite and distributing it on the surface to be lubricated. These lubricants are fully described in the pages of this catalogue.

Another production is a pipe-joint compound that is claimed to be better than red lead and cheaper also. Still another and very important material into which graphite enters is Dixon's Silica-graphite paint, which has an enviable record extending over twenty-five years. Silica and graphite form the pigment, and the oil is kettle-boiled linseed oil. Roofs and exposed metal surfaces painted with this material have lasted 15 or 20 years without repainting. It has great covering qualities and is untouched by heat, cold, dampness, salt air, alkalies or acids. A gallon ready mixed for the brush will cover 600 square feet (one coat) of metal surface.

Among the other graphite productions listed in this catalogue, we might mention graphite cycle preparations, electrotyping graphite, Dixon's famous crucibles, phosphorous chargers, founder's core wash, plumbago facings, crucible clay and graphite mixture, belt dressing, and last but not least, the widely known Dixon's American graphite pencils, which we have no hesitation in saying are the best made. We advise our readers to write for one of these catalogues and learn in greater detail than we can give here the value of these graphite productions.

The Richards Automatic Belt-Driven Air Compressor.



The Richards Automatic Belt-Driven Air Compressor.

The field for a belt-driven air compressor that shall be entirely automatic and require no attention is so evident that we need not enlarge upon it. For many shops of moderate size in which compressed air is needed it furnishes the cheapest and best method of getting the air. The machine here shown is entirely automatic. It has two 10 by 10-inch cylinders, placed vertically, with their pistons driven by cranks on a horizontal shaft above them. The belt pulleys are 56 inches in diameter and 8 inches face. The cylinders are not compounded, because it is believed that the gain in the absence of an intercooler is inappreciable. The inlet valves are vulcanite disks and very light—less than an ounce each in weight. The delivery valves are of steel.

The normal position of the belt shipper is with the belt on the driving pulley, and it is drawn into that position by springs. The vertical diaphragm at the right of the shipper is piped to the air reservoir, and when the pressure rises to a predetermined figure the diaphragm overcomes the springs seen on each side of it, and in its movement operates a slide valve in that part of the case seen between the springs. This admits air to the second diaphragm which is connected to the shipper, and which it operates against the resistance of springs located in the base of the machine and attached to the horizontal lever under the diaphragm. When the pressure falls the vertical diaphragm moves the slide valve and puts the horizontal diaphragm in connection with the atmosphere, and then the springs in the base of the machine pull the shipper over and the compressor starts again.

The compressor is from designs by Mr. Frank Richards, and patents have been applied for. It is made and sold by Mr. M. C. Hammett, of Troy, N. Y. Three of these machines have been in successful operation for months in the shops of the Lake Shore Road, and another in the shops of the New York, Ontario & Western Road.

The Neafie Insulated Joint.

The Neafie Insulated Joint, shown in the accompanying illustrations, is a truss plate or chair of iron or steel, bent with sides inclined upwardly. Upon this plate rest the ends of the two rails, between which it is usual to place vulcanized fiber or a wooden washer. The rails do not rest directly upon the truss plate, but upon an insulating plate, seen in Fig. 3. Under this is a metal plate, slightly thinner than the insulating plate, contiguous to the latter, so as to transmit the concussion of car and locomotive wheels mov-

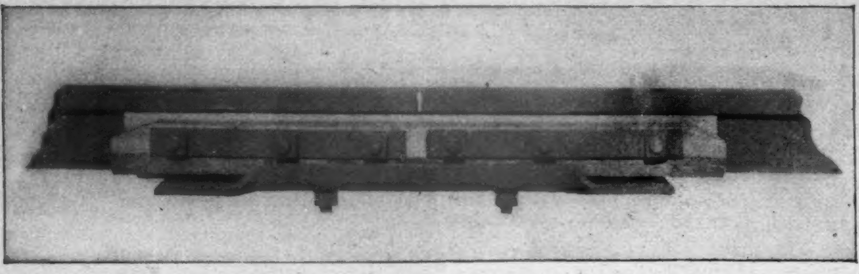


Fig. 1.

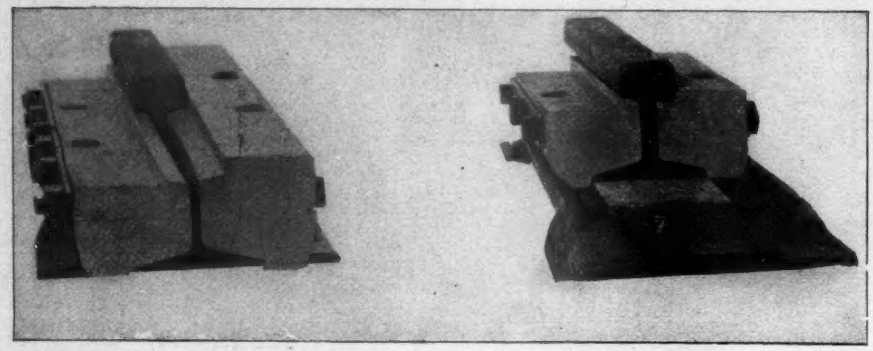


Fig. 2. Fig. 3.

The Neafie Insulated Rail Joint.

ing across the rail joint from the insulating to the metal plate and, at the same time, preserve the insulation of the joint.

In addition to the above, there are wooden blocks and iron plates to splice or bind the ends of the rails; these splice bars are secured to the iron plate or chair by four vertical bolts, and when these are screwed up the splice bars are brought to bear hard upon the inclined surfaces or side of the chair or truss plate, thus making impossible the spreading apart of the rails. The usual number of fish-plate bolts and nuts are also used in securing the wooden blocks to the rail. These joints are equipped with Kleman patent nut locks and washers throughout, and in this way the loosening of nuts upon bolts is prevented.

When the joint is thus put together it forms a perfectly insulated one, as well as giving strength and support to the ends of the rails.

Regarding the life of the joints, it is stated that they have been in continous use on several of our great railroad systems for upward of two years, and reports show that they are still in first-class condition, and the cost of maintenance has been little or nothing.

The manufacturers are the Allison Manufacturing Company, which has just completed arrangements for the sole manufacture of this joint in the United States, and Mr. J. S. Brewer, 1030 Monadnock Block, Chicago, has been appointed its representative for the State of Illinois and Milwaukee. The joints have been largely used on the Delaware, Lackawanna & Western Railroad and Pennsylvania Railroad for upward of two years, with most satisfactory results, and are on trial on many of the other roads, such as the Lehigh Valley; Chicago, Burlington & Quincy; Chicago, Rock Island & Pacific, and Chicago and Northern Pacific.

The Progress in the Manufacture of Iron and Steel in America and the Relations of the Engineer To It.*

BY JOHN FRITZ, BETHLEHEM, PA.

(*Continued from page* 30.)

My father being a millwright and machinist, as well as a small farmer, did all the important repairs for all the mills; in this shop consequently I spent all the spare time I could get off the farm, and it was a rare treat for me to get there. The tools consisted of two small lathes for turning iron and one for turning wood; all of them had wooden "shears" or beds. There was also a machine for cutting light gears, which to me was a great curiosity; there were several vises, and quite a number of small tools; one they called a "doctor," which was used to correct "drunken threads," as all screws of any importance were cut with the chaser. A few years later I frequently wished I had one of them to straighten up some crooked threads that I would unfortunately get on my hands.

In 1838 I went to learn my trade. In the machine shop there were about the same number and character of lathes as in the shop mentioned, but they were larger, one of them being a double-ender, for the purpose of boring out wheels that were too large to swing over the shears. There was also a drill press, made out of a lathe-head casting, bolted against a 12 by 12 inch wooden post; it was not a very sightly machine, but it did good work for the time. The shop made small brass castings, built small boilers and small engines, and did all kinds of country machine and blacksmith work; made our own patterns, without any drawings. It was from this shop that I was sent out from time to time to do some repairs at the small charcoal furnaces, forges and mills. The rough training I had at this primitive shop proved of great value to me in after life.

In 1854 I went to the Cambria Iron Works at Johnstown, and well knowing the importance of having good tools for the completion and perfection of such a plant as that was intended to be, I earnestly urged the company to get some of the best tools that were built, which they consented to, and at the same time had some special lathes built, and made much heavier than any that had been previously designed. This was the commencement of a better class of tools about an iron works, and facilitated the great improvements which soon after took place. But this is over 40 years ago, and what was a good tool at that time is a very indifferent one to-day, as the machine-shop equipments have fully kept pace with the times. The builders have not only perfected the machines in general use, by making them heavier, more powerful and more convenient, but they are building special tools for almost all manner of purposes, which greatly facilitates, perfects and cheapens the work, and renders it possible to get parts of a machine made in different shops, and have them all fit together as though they had all been made in one place.

I look back to my early days in the shop, now nearly sixty years ago, and call to my mind the equipments of the shop in the way of tools which I have already described, and compare the facilities for making drawings of to-day with those at that time, when the complete outfit consisted of a board, a carpenter's square, a pair of compasses, a bevel, a lead pencil, and a piece of chalk, and a jack plane to prepare the board for another drawing. After at time we adopted the plan of making models in skeleton, full size, especially when any motion was to be worked out, and also made, when it was possible, all the drawings full size; when too large to admit of this, would make important sections full size, and this practice I am not ashamed to follow at the present time, as it has many advantages.

The small shop tools for a lathe consisted of a hook tool with a sharp tit on the bottom to hold it on the rest (which was made of soft wrought iron); the tool was made out of a steel bar about ½ by ¾ inch, generally put in a wooden stock some 2¼ inches in diameter, with a handle on the lower side, as you see on the wall. In addition to the tool just described, there was a finishing tool made in the shape of a spike-head, cutting edge on both sides, one to do the cutting or finishing, and the other to keep it in position on the rest; it also has a wooden handle, but of different construction from the handle of the hook tool, as it was held against the shoulder instead of under the arm; next was a chaser, and last, as usual, was the "doctor," to cure in a measure "drunken threads," which frequently occurred. The small tools consisted of a pair of outside and an an inside pair of calipers, a file and a steel straight-edge (home-made), 12 inches long, and was divided into inches, ½ inch, ¼ inch, ⅛ inch, $\frac{1}{16}$ inch, and one of the inches was divided into 32nds, and was used for measuring, as well as for a straight-edge.

Now let us for a moment note the equipments of a modern machine shop for comparison. First, they have a great drawing room, and a good corps of men well skilled in their art, and are equipped with everything that is essential for producing work correctly and quickly, with blue prints by the score. The machine shop of to-day is a marvel in completeness of equipments for doing work correctly and with rapidity, having special small tools for all purposes. The accuracy with which their round gages are fitted up is such that a machinist of fifty years ago could not possibly realize how it could be done. Suppose you could have in his presence separated a 1-inch gage, and held the plug in your hand for a few moments, without calling his attention to it; then hand it back and request him to put it in its place again, and find he could not get them together, he would think there were some old-time witches about.

The latter part of the present century is remarkable for the success attained in designing and perfecting instruments and methods for correcting the old and imperfect system of former years. The invention and construction of instruments of precision and the methods of their calibration and adjustments, which enable measurements to be taken within one ten-thousandth of an inch; machines for measuring tapers, which enable the mechanic to fit taper work with almost the same perfection and facility as parallel work or refinement of practice peculiar to modern times, and of which a mechanic of 50 years ago could have no conception, either of their possibility or practical value.

The great improvement which has taken place in the manufacture of steel, both in quality and quantity, and its general adoption in machine building; the using of steel higher in carbon, the introduction of nickel, and the treatment by oil tempering, have rendered the tools I have already referred to, practically useless for a very large part of the work that is now being done; consequently new tools are required that are much heavier and more powerful than any that had been built up to this time.

The Bethlehem Iron Company has 4 lathes in use, all of the

* President's address before the American Society of Mechanical Engineers.

same pattern; 1 of them is used for what is called a cutting-off lathe, and frequently employs 12 tools, 6 on each side, made out of the best steel that can be had, size 1 inch by 6 inches, and are forced to cut all they will stand. These lathes have had work in them weighing over 190,000 pounds. They have planers that have finished castings that each weighed 165 tons, and the finishing of of nickel-steel armor plate requires tools of great power and special design.

The workmanship on the cranks and shafting has to be of the highest order, consequently the machines on which they are finished have to be massive and of great power, and fitted up in the best possible manner; the journals of the shaft must be round and perfectly parallel, and the flanges must be true with the axis or body of the shaft, and the parts generally have to be interchangeable, the flanges being plain on the face, relying entirely on the bolts in the flanges to keep true to each other. This requires handwork of a very fine order. Shafts 18 or 20 inches diameter, 60 or 70 feet or more in length, all bolted solidly together, laying in V's, can be turned easily by one man with a lever of 36 inches in length; this proves the high character of the work.

In speaking the manufactured products of iron and steel, I shall take up first the subject of forgings made of iron. These were originally made out of faggots (bundles of iron bars) heated in a reverberatory furnace, and welded and shaped under a hammer which was generally too light; the force of the blow did not reach the center, and the result was that forgings of any considerable size were unsound in the middle. This occurred to such an extent that, in my early connection with machinery, I discarded forged shafts entirely and substituted cast iron melted in an air furnace, and continued to use it, with one single exception, until we learned how to make, heat, forge and treat steel in such a manner as to practically get it solid and free from internal strains, and was ready to recommend it as the proper material for shafts and miscellaneous forgings.

I have known the early wrought-iron shafts to fail and be replaced by cast iron, which, never gave any trouble, and a practical person giving the subject any serious consideration will see at once why a cast-iron shaft should be better, and safer than wrought iron, as they were made.

In the first place, you can, by the use of the proper kind of pig iron, intelligently melted in an air furnace, get a tensile strength of 32,000 pounds per square inch, and, with a proper sink-head you can get practically a solid casting, and I might add homogeneous and close in the grain; while, as I have already stated, the forged shaft will, in all probability, be unsound in the center and coarse in the grain, and its tensile strength will be little if any greater than cast iron.

I shall now refer to the single exception which I have alluded to, believing a brief description of the shafts, and give the reason why I used wrought iron and steel in place of cast iron, which had served me so well for a period of nearly fifty years will be interesting and instructive to you all. First, the reason for using wrought iron and steel in place of cast iron was, I wanted a three-throw crank for a three-cylinder engine, and had to use a built-up crank; at that time a solid forged crank of such dimensions as was needed could not have been made in this country. The stroke of the engine being short, reduced the distance from center of shaft to the center of crank pin to such an extent that I was compelled to reduce the diameter of the shafts to the smallest size consistent with safety in order to get sufficient metal between the holes in the crank to give the required strength. Steel at that time being more expensive than wrought iron, it was economy to use iron when it would answer the purpose. I concluded to use steel for the main shaft and the first crank pin, and the others wrought iron. The iron shafts and crank pins were from, what I considered at that time, the best forge plant in the country. Having had some previous experience in a small way with both metals, and the results not being altogether lovely, I thought it prudent to see in what condition the metal in the center of these forgings was. In order to show this, a hole about 4 inches in diameter was bored through the center of them all, seven in number, and all were unsound in the center; in the iron the imperfections ran longitudinally, and the four-inch hole practically cleaned them out. The steel shaft, which was about 14 inches in diameter and some 12 feet in length, proved unsound in the 4-inch hole, and showed serious imperfections in the form of large cracks or openings running, as it were circumferentially on the inside of the shaft; the hole was enlarged to about six and one-half inches in diameter, and some of the imperfections were still visible. The position of the shaft was such when in use that, should it give way, it would not be likely to do any serious damage; so we concluded to use it. When the hole was bored through the steel crank pin it showed so badly that we split it in two lengthwise. It was full of cracks, some of them extending almost to the outer edge. Its condition was frightful to a person who was contemplating the building of a large plant for the purpose of making steel forgings, as I was at that time. My experience in making steel, in heating, rolling and forging, had already convinced me that it would require great skill, and still greater care, to prevent imperfections in the interior of steel forgings, yet I was not prepared to witness anything approaching the condition which the splitting of this forging revealed. The chemical analysis, as I remember, was fairly good. There had been some blow holes in the ingot, as there are in too many of them. To my mind the trouble was almost entirely due to two causes; first, the ingot had been put into a hot furnace and heated up too rapidly, pulling the center apart, causing internal ruptures; secondly, by being forged under a light hammer, in all probability using steam on top of piston, which gives a quick stroke and does not give the metal time to flow or the force of it to reach the center of the ingot, consequently elongating the outside more rapidly than the interior, and the importations, whatever they may be, are always the weaker parts and the effect of the blow on the outside elongates them, as it were, by pulling them apart more rapidly than the sound outside of the ingot; consequently the imperfections were greatly augmented.

Mr. W. F. Durfee, in a paper read before the Franklin Institute on the "Conditions which Cause Wrought Iron to be Fibrous and Steel Low in Carbon to be Crystalline"—and a most admirable paper it is, and one which every maker and user of steel should read and study, in regard to unsound ingots—says: "It is a common opinion that one of the reasons why steel forgings are often found hollow in the interior is the failure to work them under a sufficiently heavy hammer, but no hammer, not even the hammer of Thor, can do no more than aggravate the evil of internal ruptures of ingots in steel." This is well said, and is a truth that cannot be gainsaid. It was due to imperfect or unsound ingots, lack of knowledge in heating, in forging, and also the want of proper skill to treat the forgings properly, after they were made, that caused so many failures in the early days of its manufacture, which made many people think and believe that there was some mysterious uncertainty in the metal and discard its use altogether; and to some extent this impression is still in existence, for, to my surprise, only a short time since quite a prominent engineer said to me that he was still using wrought-iron shafts on account of the uncertainty of steel forgings. To those persons who were using steel low in carbon, for various purposes, I urged the use of a higher grade of steel, well knowing it would answer their purpose better; I was answered by the saying that it required too high a grade of skill to utilize it; they must have a material that any one could handle; consequently the steel was so low in carbon that it was no better than iron, and in many instances not as good. My own early experience having fully convinced me that nearly all the failures were due to the use of improper kind and grade of steel, being too low in carbon, and in most instances so high in phosphorus and sulphur that nothing but failure could be expected, yet it was useless to attempt to convince many that a higher-carbon steel of proper analysis would answer their purpose. They said no; we are going back to iron; we know what that is, and we can trust it. I was told that a machinist had let a locomotive crank pin fall off his shoulder on the shop floor and it broke in two pieces, and I could readily imagine that a condition could exist that would render it liable to break from the most trifling cause. I also was told that in pinching a locomotive back and forth in the shop, in order to set the valves, that a steel crank pin was broken and many other mysterious cases, as the laymen called them, were reported. At all events, the general condition of steel forgings was such that it was not safe to use them where loss of life might result from failure. I have already alluded to phosphorus and sulphur as most deleterious elements in steel. There are, however, still some people who contend that its presence to an extent not in excess of twelve one-hundredths (.12) will do no harm in low steel, and I have been told quite recently that a person who posed as a mechanical engineer, and a steel maker, endorsed that position; and he may be both, but I will take this occasion to put myself on record by saying that I have no use for it in any shape or form whatever; by keeping it low you can increase the carbon, which is in the right direction for good steel.

Having shown you something of the character of steel in its early days, and its failures, and the disrepute into which it fell, let us suppose the mechanical engineers, who at that time were the men who had charge of the practical part of the steel business, would have said that steel was no good, and dropped it, and said we will go back to the old concrete of metal and cinder again—then where would we have been to day; but they did nothing of the kind, and let me tell you the mechanical engineer of that day was not made of that kind of material, for the engineers who, in face of the prejudices of a continent, advocated the substitution of steel for iron were men who regarded obstacles and prejudices as things which were made to be conquered. He took off his coat, called to his aid that all-important adjunct to steel-makers, the chemist, and then went to work as he had done many times before when things looked equally discouraging, and produced the grandest material for construction purposes that the world has ever known, and which will enable engineers to solve great constructive problems, that, but for the improvements in the art of steel making, could not have been accomplished.

Now, after all the labor, anxiety, vexations and disappointments that have been suffered, and in the face of the final success, are we to be told that it cannot be used, because it requires too much skill and careful treatment in both forge and shop? I sincerely hope and believe that we are not. But there is another all-important feature on this subject, and that is the practical knowledge which is necessary in order to select the proper quality of steel to be used for the various purposes which it is to be applied to, and the want of this knowledge has been the cause of many failures, and this knowledge can only be obtained by a large practical experience. When I say proper quality of steel for various purposes, I do not mean steel alone low in phosphorus and sulphur (for all steels should be low in both these obnoxious elements), but what I mean is the proper amount of carbon to suit the physical conditions which it will be called upon to endure, and in this experience must be our guide. Fortunately, much experience has already been obtained, so that there ought to be but little excuse for mistakes and failures.

It is not the object of this paper to enumerate the various purposes which steel should be used for, or to indicate the proper amount or grade of carbon to suit the various and changeable conditions that it will be subjected to, but simply to call your attention to the importance of proper selection.

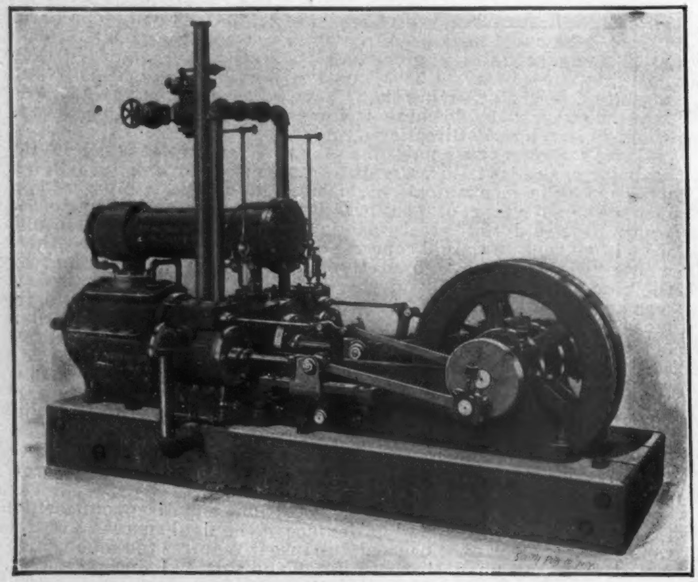
I will now speak briefly of the subject of forging hollow steel shafts, as none other should be used. If not large enough in diameter to forge hollow, let them be bored out and properly annealed. Next I will call your particular attention to the all-important matter of the system to be adopted. While I was contemplating the design of a forging plant for making both light and heavy forgings, fortunately I met Lieutenant Jaques, U. S. N., who was secretary of the American Gun Foundry Board, and had just

returned from abroad, where the Board had been inspecting the naval armaments of Europe, and had also investigated the various systems of forging gun material, and he was so highly impressed with the Whitworth hydraulic system of forging that he made arrangements with Sir Joseph Whitworth & Company, Limited, of Manchester, England, for the machinery for a complete forging plant, to be erected in any place in the United States and by any parties that he might desire to make arrangements with. Shortly after Lieutenant Jaques' return he visited Bethlehem, and told me what he had seen done in the way of hollow forging. I was so impressed with his account that I at once advised the Bethlehem Iron Company to make arrangements for the machinery for a complete plant, which, after a time, they concluded to do, and through Lieutenant Jaques a contract was entered into with Sir Joseph Whitworth & Company, Limited, for the machinery for a complete forging plant. It is to Sir Joseph Whitworth and his able superintendent, Mr. M. Gledhill, that the world is indebted for the most perfect system for forging that has ever been devised, and to Lieutenant Jaques the credit is largely due for its introduction into this country. In connection with the forging plant was included a hydraulic compression plant, under which the fluid steel is compressed during its solidification, which practically prevents cracks, piping and blow-holes, and greatly reduces segregation, which are vital considerations in the manufacture of steel ingots. An imperfect ingot caused by piping or cracks should be condemned to remelting.

(To be Continued.)

The Ingersoll-Sergeant "Triple" Air Compressor.

The accompanying engraving illustrates one of the latest designs of steam-actuated air compressors by the Ingersoll-Sergeant Drill Company of New York. It is called a triple type air compressor, not because the compression is in three stages, but because there are three cranks. By this arrangement dead points are avoided and the machine will start promptly in any position; furthermore the angles between the crank driving the air pistons and those connected to the steam pistons, is such that the greatest rotative effect is obtained when the resistance in the air cylinder is at a maximum. This is the very reverse of the conditions existing in the ordinary straight line compressor. The absence of dead points and the nicer adjustment of work to resistance throughout each



Ingersoll-Sergent Triple Air Compressor.

revolution also make it possible to govern the compressor automatically, making it slow down or even stop as the consumption of air decreases, and to start again when the air pressure falls.

The air cylinders are compounded and are placed tandem, in the center of the machine, connecting to a crank between the fly-wheels. These cylinders are 12¼ and 7¼ inches in diameter and 9 inches stroke. There are two steam cylinders, each 7 inches in diameter and 9 inches stroke, placed on each side of the air cylinders and driving the main shaft by cranks 90 degrees from each other, and 135 degrees from the air compressing crank. The steam distribution is by means of plain slide valves.

The compressor is built to deliver air at 75 pounds' gage pressure, using steam at 90 pounds' pressure, and to run at 150 revolutions, at which speed it will compress 175 cubic feet of free air per minute. The proportions of the air cylinders may be varied for other delivery pressures that may be desired, and if so ordered the steam cylinders may be compounded. The air cylinders and cylinder heads are water jacketed, and an intercooler is used. The piston inlet valve employed so extensively by this firm is used on this compressor.

The machine is self-contained and very compact, and the workmanship is up to the high standard of this company.

Relative Wear of Copper and Zinc Alloys.

Engineering says that some experiments were recently made in France on the resistance of alloys of copper and zinc to wear. The method followed was to construct rectangular prisms of the samples to be examined, and press it by means of a definite load against a lapidary's wheel fed with "three-minute" emery mixed with oil. The amount removed by the grinding action was then ascertained by finding the weight lost by the sample. The usual routine was to take three samples of the metal to be tested and one of soft copper, each specimen measuring 5 millimeters square by 8 millimeters high. The four were then fixed to the bottom of loaded rods placed vertically over the wheel, so that the center of each specimen lay on a circle of 11 centimeters radius. The wheel was then run for two periods of 10 minutes each at a speed of 800 to 1,000 turns per minute. Taking copper as standard, the following results were obtained for the copper-zinc alloys:

Percentage of zinc.	Relative wear.	Percentage of zinc.	Relative wear.
0	1.000	40.4	1.031
10.1	.846	41.7	1.075
18.4	.864	44.7	1.148
27.1	.905	49.7	1.240
30.2	.929	60.1	Fragile
32.3	.940	80.1	.586
34.7	.950	99.6	.777
37.6	1.003		

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.—X.

BY OSCAR ANTZ.

(Continued from page 29.)

FREIGHT CARS.

In a previous article the general construction of the floor frame of ordinary freight cars was described and subsequent articles treated of those parts, which, with perhaps slight modifications, are common to most if not all classes; it now remains to describe the different kinds of freight cars which are in use.

FLAT OR PLATFORM CARS.

The simplest kind of car which can be constructed on the floor frame which has been described is the flat or platform car, which consists of the frame, draftgear, trucks and brakes, with perhaps some provision to prevent the material which is carried from falling off the car. These cars are used principally for transporting pieces of freight which are too bulky to put into any other kind of car, and which, from their nature, are not liable to be injured by the weather, and which, from their size and weight, are not likely to be pilfered. Machinery, stone and lumber are some of the more common things carried on these cars as freight and railroad companies use them almost exclusively for transporting their own material for building and maintaing the roadway such as rails, ties, ballast, etc.

On account of the absence of sides these cars are easy to load and unload, but without any superstructure the strength of the car depends entirely upon the framing and trussing, and it is, therefore, a common practice to make the side sills deeper than the others, and often more than four trussrods are used. There is also a liability of bending the car upward at the center when it is subjected to pushing strains, and it is good practice to put inverted trussrods in the car in addition to the regular ones. On many roads it is the custom, in order to avoid as much as possible the buckling of these cars, to put all flat cars at the rear end of the train, where they will be less damaged on account of their decreased momentum in case of a sudden stoppage of the train.

The material carried on flat cars is usually of such a nature that it will retain its position without any fastening or else it can be held in place by cleats nailed to the floor. Occasionally, howevrr, it is desirable to confine it within some kind of enclosure and flat cars are therefore usually provided with stake pockets, for inserting temporary stakes, to which the freight is tied or nailed or to which temporary sides or ends may be fastened. These stake-pockets are made of cast or malleable iron or pressed

up of steel plate, and are usually fastened to the side sills by means of U bolts passing around the pocket, with the nuts on the inside of the sill; the stakes are usually about 3 by 4 inches at the pocket, tapering down slightly to the top.

The dimensions of most of the flat cars in use approach closely to those of the floor frame which has been shown, viz., about 34 feet over end sills, 8 to 9 feet wide and the floor about 4 feet above the rail. For carrying some certain kinds of freight, however, special cars other than these sizes have been built, and there are flat cars of from 40 to 60 feet long, built specially to carry street cars, and others of large capacity, from 60 to 150,000 pounds, for carrying boilers, coils of cable and other specially large and heavy freight. Very often these large cars are built with a specially low floor and in some cases the draft gear has to be placed between the sills, instead of below them, necessitating a deep end-sill with a hole cut through it for the drawbar, or it has to be placed entirely on top of the floor.

Cars of larger than the usual capacity cannot be carried on the ordinary trucks and they must therefore have special ones or more than the usual number. The axles are sometimes increased in size, so that four of them will carry the weight, but as this makes an odd size of axle, differing from the present M. C. B. standards, it is preferable perhaps to increase the number of axles in each truck, and have them a standard size, and this is done in some cases, trucks being built with three pair of wheels in each. Another construction is to have two standard trucks under each end of the car, connected by an auxiliary frame work resting on the center of each of the two trucks, and the center plate of the car resting on the intermediate frame at its center. Side bearings are provided for both trucks as well as for the intermediate frame.

For transporting long timber logs, bridge trusses and other long material, it is often necessary, in the absence of special long cars, to use more than one flat car, and in loading them provision must be made to allow the cars to pass around curves easily, which is usually done by supporting the material on blocks at its two ends, without touching the floor at any other point, allowing it to oscillate around the points of support without putting any side strains on the drawbars connecting the cars.

When the load extends over from one car to another there is liability of severe accidents, should the coupling between the two cars give away, and it is customary in such cases to take the precaution to pass a heavy chain from the bolster of one to that of the other car, or safety chains are sometimes provided on these cars when considerable long material is regularly carried.

When such long material is loaded on flat cars, it is often necessary to remove the vertical brake shaft at the end of the car, and on roads on which such loads are a common thing, the brake shaft is often arranged to drop out of the way, without removing it from the car, or even disconnecting it from the chain; other roads again have the brake shaft on the side, and on some roads the shaft is done away with entirely, and the brake chain is carried upward around a pulley, and has a ring at its top which is pulled upward to set the brakes and which prevents the chain from dropping down too far when not in use.

On account of not having a superstructure to strengthen the frame, a flat car is perhaps the least adapted to being built longer than the ordinary length of cars, and most of the long flat cars which have been built recently have the frame made of metal. Channel bars and I-beams of either iron of steel are used in some instances for sills and crossties and sometimes also for body bolsters. In other cases the side-sills are made of plate iron, deeper at the center than at the ends, and reinforced by angle irons riveted on.

One of the difficulties experienced with cars with metal sills, is the inconvenience of fastening the floor, which is usually made of wood, a common way being to bolt a piece of timber to the side of the iron sills to which the floor is nailed, which, of course, adds considerable to the weight of the car.

Another construction which does away with the wooden floor, consists of plates of steel, bent in the shape of channels, riveted together so that the flat part of the channels forms the floor, the flanges standing vertically and acting as sills.

As yet, no very large number of metal cars are in use, and even these may be said to be in the experimental stage; further developements in this line are looked forward to with much interest.

GONDOLA CARS.

Gondola cars are used for carrying material which is not injured by exposure to the weather, but which requires an enclosure to hold it, and as more coal perhaps is carried in these cars than any other material they are often called coal cars.

A gondola car can best be described as being a flat car with a box permanently fastened on top of the floor, but without any cover or roof, and usually provided with some means of unloading the material without having to throw it over the top of the box.

The size of the box varies more or less, together with the length and width of the cars, the usual height being from 3 to 4 feet for the floor frame which has been shown. The sides and ends of the box are made of about 3-inch material, white, Norway or yellow pine being used, according to circumstances. The height of the box is made up of several plank, usually from 9 to 12 inches wide, the side plank having keys of cast iron inserted in the joints at several points in their length to give vertical stiffness to the sides. The plank are fastened to stakes set in stake pockets on the side sills and the sides are held down to the floor by strap bolts bolted to the plank, with the ends passing down through the side sills, with nuts on the bottom. The ends of the box are sometimes also supported by stakes and are then fastened to the sides by means of core bands, inside and out, bolted to both sides and ends. The top of the box is protected by straps of flat iron secured by lag screws.

As gondola cars are generally loaded from the top and sometimes also unloaded that way, it is not desirable to have anything passing across the box which might interfere, and it is therefore customary to have the sides depend for their strength only on the stiffness of the material in them, reinforced by the side stakes to which they are fastened, without being connected from side to side other than at the ends. The stakes near the center are sometimes arranged so that two of them are located over the crosstie timbers and extend down to the bottom of these, thereby giving them a longer bearing and making them better able to resist the pressure on the sides. Sometimes, also, the distance between the stakes, near the center, is decreased, for the same object.

Another method of strengthening the sides of gondola cars, which, however, seems to have been abandoned in recently built cars, is that of trussing them, the truss rods passing through the upper planks near their ends, with posts under the rods on the outside of the car, near the center, and nuts bearing on washers against the ends of the box.

The ends of the box on gondola cars are either fixed, as a stationary part of it, or are movable; for the latter purpose the usual method is to have the end plank fastened together to make one door, which is hinged at the bottom, so that it can be dropped down on the floor of the car inside of the box, allowing the load to be passed through the open end thus formed.

Another method is that of having the end arranged in guides on the sides of the car, so that it can be lifted up nearly to the top of the box, stops on the bottom preventing it from being pulled out of the guides. This arrangement is used on some cars in the coal trade in connection with a machine by which the entire car is unloaded through the open end by being elevated at the other end. The box on gondola cars usually does not extend to the outside of the end sills, but stops a foot or so inside of it to provide a foothold for trainmen while using the brakes; steps usually made of flat iron in U shape and handholds on the side of the box are provided for assisting to mount the platform. When the box is over four feet high steps should be provided on the ends to assist the trainmen to reach the top of it.

Gondola cars are generally arranged with doors in the floor, through which material in bulk form can be unloaded, and there are a number of different arrangements of these doors in extensive use. The simplest is perhaps the so-called drop bottom, in

which usually two openings are made in the floor at the center of the car, each extending in width from the center sill to the outside intermediate sill, the length being limited by two headers placed across this opening about 5 feet apart, these headers being mortised to take the ends of the short inside intermediate sills when these are used. The bottoms of the sills and headers are in one plane, and the doors when closed are held up against the opening thus formed. These doors are double, and each is made of two or three planks held together by straps of iron, which terminate in an eye forming part of a hinge, the other part, usually two eyebolts or straps of iron ending in eyes, being fastened to the headers.

The plank usually extends across both openings in the floor, a narrow piece of flooring being placed over the center sills and the space between them, forming a convenient place for trainmen to pass over on when the car is empty. The drop doors are occasionally placed so as to open longitudinally with the car instead of transversely. The doors are held in place and also drawn up into place by means of chains, fastened to them by eye-bolts, the other ends being secured to a shaft of round iron passing across the car at its center and resting on cast-iron pieces placed on the floor. This shaft terminates at one end in a square, over which is placed a ratchet wheel, the square projecting far enough through this to enable it to be turned by means of a wrench. A pawl, engaging the ratchet wheel made usually of a bar of square iron hung at one end and a dog of eccentric shape for holding the pawl in place when the doors are up, are also provided and are generally fastened to a plate of iron on the side of the box; the other end of the winding shaft projects through the side of the box, and holds a pin and washer to prevent the shaft from moving endwise.

Although winding shafts like that described have used almost exclusively for dropdoors ever since these have been in existence, there are quite a number of objections to them, one of the principal ones being that the shaft becomes bent by pieces of material striking them when the car is being loaded, which makes them work hard and wind the chains up unevenly; another objection is that the chain will sometimes wind up on itself, also causing uneven raising of the doors; and another is that the chains are very liable to break, dumping the load upon the road; this latter trouble is sometimes also caused by the pawl on the ratchet wheel becoming disengaged. A number of designs have been introduced whose object is to do away with some of the objections mentioned, and a few of these will be described.

One of the earlier methods to do away with the chain is that of holding the doors up by means of a rod terminating at its bottom end in a tee which when placed across the opening between the doors will hold them up, but when turned one-quarter way around it allows them to drop; the doors have to be raised to their place by lifting them up from the bottom. This is one objection to this device, and another is that a piece of timber has to be placed across the box at the top to hold the upper end of the rod, which is provided with a means of locking it in place and terminates in a square for a wrench to turn it.

Several other devices have a chain and shaft for raising the the doors, but the shaft is not exposed where material can drop on it and is provided with worm wheels for the chain, which prevents the latter from winding on itself; the doors, when in place, are held up independently of the chains by means of latches which are forced out by springs or weighted levers, and which are drawn back, when the doors are to be dropped by means of cams or levers attached to another shaft. A wheel is sometimes attached to the winding shaft and the ratchet and pawl are omitted, in order to prevent the doors from being partly closed and left in that position. An innovation which has been introduced in connection with the device just mentioned is that of having the drop-doors close flush with the top of the floor, doing away with the pockets which would remain full of the material with which car is loaded, when being unloaded through the end by being inclined, as has been referred to.

Other designs use a combination of rods and levers to raise the doors and hold them in place, which, while doing away with chains, introduce other objectionable features, and it might be said that as yet no entirely satisfactory method has been devised for raising and holding up the dropdoors of gondola cars.

While dropdoors in the floor afford a means of unloading cars through the bottom, there is, nevertheless, considerable labor attached to this performance, as but little of the load will run out of the door openings and all that which does not lie immediately at these opening must be brought there by artificial means. To overcome this point, the bottoms of gondola cars are sometimes made to incline toward the door openings, the amount of the slope being dependent on the height of the box, the depth of hopper permissible, and on other details of the car. A car on which the entire bottom slopes does not answer very well to load anything but material in bulk from, and the bottom of hopper cars is, therefore, often made so that only part of it slopes, the ends of the floor being left as in other cars, on which material can be placed and long material can be loaded to cover the entire hopper. This, however, introduces the objection again of having to use a shovel to some extent to unload the car. On roads, however, which have an extensive trade in bulk material, such as coal, where the labor saved in unloading offsets the loss incurred in hauling the empty car back to be re-loaded, it is becoming the practice now to build gondola cars with the entire floor on a slope, which allows all the lading to run out of the door openings without any manual assistance other than opening the doors.

In order to get sufficient slope to the hopper, it is necessary to extend it below the line of the sills, and the center sills are usually carried through the hoppers, being covered over by short pieces of flooring; this space included by the center sills often serves to carry the brake connection from one end of the car to the other.

Hoppers usually also slope slightly at the sides, in order to reduce the width of the doors to the space between the rails; to get as great a slope as possible on the ends, two openings are sometimes provided, separated as far as the trucks will allow, and the part between them is also made to slope from the center of the car each way to the openings.

The dropdoors of most hopper cars close in a horizontal position, but recently some have been built in which the doors, when closed, stand at about a right angle with the slope of the hopper, thus making a slight angle to the vertical; they are hinged at the top and are worked by means of rods and levers, forming a toggle joint.

To unload gondola cars through the dropdoors, they must be placed on elevated trestles having openings between the rails through which the load can fall. This is not always desirable or possible, and there are other cases where it is desirable to have the load dumped on the ground on the side of the car. For this purpose side dump-cars have been devised. These consist of a box similar to that of the gondola car, but the lower part of the sides is movable and is hinged to the upper part, and is divided into a number of parts or doors, which when closed slope toward the car, and when released fall to a vertical position. The floor is elevated at the longitudinal center, and slopes down to meet the bottom of the doors. The latter are held in place, when closed, by chains winding on worm-wheels on a square shaft running through the center of the car, the other end of the chain being fastened to a link which connects it to the door, these links working in slots in partitions which divide the length of the car into as many spaces as there are doors. The shaft is turned by means of a ratchet-wheel on the end, situated over the platform formed by the projecting end sill, a pawl attached to a lever being used to turn the wheel.

A number of ore-cars are used on several roads, built similarly to the last-described cars, having a capacity of 80,000 pounds, using three trucks, the middle one being placed at the center of the car without any center-plate or pin, the body of the car resting on rollers which allow the necessary adjustment on curves, the two end tracks being arranged with center-plates in the usual manner.

(To be Continued.)

Notes by the Way.

The present depressed condition of railroad business makes the gathering of notes and information a difficult and a somewhat depressing task. For this reason it is to be feared that rather a somber tone will pervade the report of a recent hasty journey which was made from the Metropolis to St. Louis. Other interests and not those which usually induce an editor to travel led to the journey, so no special effort was made to collec information, other than that of merely calling on railroad officers in a very casual way, and thus consuming some of their valuable time in what may be called professional gossip, relating to what they are doing and expect to undertake.

In Baltimore, Mr. Harvey Middleton, the General Superintendent of Motive Power of the Baltimore & Ohio Railroad, had just returned from making a test of one of his new ten-wheeled passenger engines, which was very satisfactory, and he then felt assured that they were an undoubted success. Having been absent for some time, there was not much opportunity for talk or gossip. His frame of mind was, however, somewhat more cheerful than that of most railroad men at this time, which was perhaps partly due to the fact that the Baltimore & Ohio being in the hands of a receiver, imposes no responsibility on its employees to pay dividends, and many other obligations may be staved off to what may be called a future by and by. Various improvements are contemplated, among them a new erecting shop at Mount Clair shops in Baltimore, with longitudinal tracks and travelling cranes of the most modern design and plan. A large order for freight cars is pending and the management is hopeful of improvement in business and renewal of prosperity. May they not be disappointed, will be the ejaculation of all who hear of it, especially the stockholders.

From Baltimore to Altoona is but a few steps—that is, you step into the car at the one place, and in a few hours out of it at the other, and that is about all the labor of the journey. At Altoona, increased and continued efforts are made to economize and reduce expenses. Reports of businees were unfavorable, men in the shops are working short time, and little new work is in progress, and the universal question was "When will things be better?"

In brief interviews with Mr. Casanave, Mr. Atterbury, who has succeeded Mr. Wallis as Superintendent of Motive Power at Altoona, Doctor Dudley, Chemist, and T. R. Browne, Master Mechanic in charge of the Juniata shops, the slackness of business and need of economy was reiterated. At Juniata we acquired some interesting information about Mr. Browne's oil furnaces, which will be given in full this month. Dr. Dudley was then interested in the disinfection of passenger cars, a subject which has been taken up by the United States Marine Hospital service in Washington. A new disinfectant, known as "forma lin," is being experimented with which promise excellent results. Experiments have shown what might have been expected, that the dirt which accumulates in cars is very prolific in disease germs, and the microscope makes it seem possible to catch almost any disease in a car. The new disinfectant vaporizes at low temperatures, and if confined inside of a car, permeates every crevice and into the texture of the material, if it be at all porous, and it is said to be the most destructive agent of microbes and other infinitely little beasts, which has yet been discovered. It is certainly a subject of very great importance and worthy of the most thorough investigation.

At the Pittsburgh Locomotive Works they have a splendid plant, with little to do. These works have been remodeled and to a great extent rebuilt within a comparatively few years, and it is now one of the most complete locomotive shops in the country, with facilities for building a large number of engines per year. Mr. H. K. Porter, of the locomotive works bearing his name, reported that they were giving a great deal of attention to compressed air locomotives, and have recently been making some new experiments in reheating the air with excellent results. Much time, money and ingenuity have lately been expended in this direction.

From Pittsburgh a night journey takes a traveler to Indianapolis, which, at the time it was visited, was drenched with rain. It is headquarters of the machinery department of the Cleveland, Cincinnati, Chicago & St. Louis Railroad, over which Mr. Garstang presides. He is well housed in comfortable offices, and administers the affairs of his department which now covers 2,290 miles and 548 locomotives. Like many other heads of machinery departments he has had more or less trouble from the breakage of car and locomotive axles, which has led to the examination of many specimens by etching sections of them with acid. He has collected numerous interesting etchings, which show many degrees of goodness and badness. It is a somewhat fantastic belief of Swedenborgians that every transgressor leaves its record in the human body, and that after death each person's body will be taken possession of by angels, who will examine it from the soles of the feet to the crown of the head, and will determine therefrom what his life and conduct have been. There is some anology between the etching process here referred to and the doctrine described, the action of the acid shows very plainly the character of the original material from which an axle was made, and also how it was worked during the process of manufacture, the purity and the impurity of the material used and reveals its original nature and many of its defects. The process may therefore be regarded as a sort of mechanical Swedenborgianism. If it produces as good results in its application as the religious faith referred to does in some of its believers it would be an incontrovertible reason for its adoption.

The shops of the C. C. C. & St. L. road are some miles out from Indianapolis and there was not time to visit them. The local shops of the Pittsburgh, Cincinnati, Chicago & St. Louis, are, how ever, in Indianapolis, and are presided over by Mr. Swanson. These shops are said to be the most idyllic of any in the country. They were built among a grove of forest trees, and those in charge had the good sense and good taste to leave the trees standing and lay out the grounds among them in paths and walks, so that the buildings are now located in a small park. Little is done here excepting repair work, and at present not very much of that.

St. Louis was smoky as of old. It is interesting to take some of the many cable and electric car lines, and ride from the center of the city to the end of the lines. The city, it need hardly be said, is located on the western bank of the Mississippi, and it has the whole of the eastern portion of the State of Missouri to grow into. Lines of electric and cable roads have been built from its center, radially, and extending in many different directions. It may be stated as a general proposition, that the available area into which a city can grow is increased with the square of the speed of the means of transportation. The increased speed of electric and cable cars has thus opened up a very large territory, which has been partially occupied by the population, and has made suburban and semi-suburban residence practicable for many who could not live in such localities, if they had to depend upon the slower means of transportation, which aforetime was provided in this city by the patient mule. Detached houses, with a liberal amount of ground around them, are frequent, and in the newer parts of the city there is no overcrowding, and there is still much unoccupied ground.

A stranger is struck with the size of many of the cars on the electric roads. Many of them have eight wheels and are carried on two trucks, and are nearly or quite as large as the cars on the New York Elevated Railroad. Others have six wheels, with an arrangement which permits the axles to assume radial positions in relation to curves. On the cable lines a closed four-wheeled car is run behind an open motor or "grip" car. The incessant clanging of the bells, and the agility required to avoid being run over, does not add to the sense of security one has in the streets.

The only railroad shops of any considerable size or note in St. Louis are those of the Missouri Pacific Railroad. Mr. F. Reardon is Superintendent of the Locomotive and Car departments, and Mr. L. Bartlett is Master Mechanic.

One of the noteworthy features of these shops is the general use of compressed air for various purposes. In the machine shop we were shown an arrangement which commended itself. It was in the department where the connecting and coupling rod work is done. Over this and attached to the ceiling is a circular track almost 25 feet in diameter with a radial arm pivoted at one end at the center of the track, and the other end running on a trolley on the circular rail. The arm also has a trolley running on it radially to the track, which carries an air hoist, which is suspended therefrom. Of course, any point under the circular track can be reached by this appliance, and there is no obstruction of the floor or space over it.

Quite a number of small three-cylinder engines, of the Brotherhood type, have been built in these shops, and are mounted on three-wheeled trucks, which can be moved anywhere to do work which cannot conveniently be brought to a machine. This work includes the boring of cylinders, facing-off valves, drilling of various kinds, etc., etc. These engines have been found to be very convenient, and have been supplied to most of the shops on the line of the road.

Another device is a pneumatic ash-hoist. This consists of a track which is elevated about $2\frac{1}{2}$ feet above the ground, and is supported on cast-iron stands or columns placed about 7 feet apart, on the top of which inverted rails are placed, and the running rails on top of these, but not inverted. This brings the bases of the two rails together. The object of this is to secure sufficient strength to carry the loads on the rails, which rest on supports 7 feet apart. Square receptacles or buckets about 18 inches deep are made to go between the rails and their supports, and as the latter are elevated the buckets are below the track. When an engine is to be de-ashed, it is run on the track and over a series of the buckets, into which the ashes are raked. When this is effected the engine is backed off of the track, and at the same time draws a portable crane which is mounted on a four-wheeled car on the track into a position in which it can take hold of the buckets and swing them over and dump the ashes into cars on an adjoining track. The crane is operated by compressed air both for hoisting and swinging it. The air is supplied by the brake pump of the locomotive. Of course, the track might be laid on the surface of the ground, and pits could be excavated to receive the buckets.

Another device, which it is also said saves a great deal of time and labor, is an arrangement for removing spring hangers, but this could not be explained without engravings.

They are also making what, to the writer, was a novelty in tanks for locomotive tenders. The sides and end of the coal-pit of the tank, instead of being made vertical, are made with a considerable inclination, so as to approximate to a hopper form. This carries the coal forward, so that little or no handling is required by the firemen.

The practice of burnishing the journal bearings of axles is also much used in these shops. This is done with a steel roller, similar to that which was described and illustrated in connection with the Altoona shops in our issue for January. As the roller moves along the surface of the journal it leaves a distinct ridge between the portion which is compressed and that which is not, which can be readily felt by touching it with a finger. Very excellent results are obtained from the more satisfactory wear of journals which have been burnished compared with those which have not been so treated.

One of the complaints which is heard in the Pacific shops, and which will doubtless be reiterated a great many times hereafter, is the lack of firebox capacity in modern engines. Western coal is inferior to that which is used in the Eastern States, and the size of engines has grown, but the width of their fireboxes has not. The result is that the bellies of iron horses are not big enough for the work they have to do. There is a distinct demand growing up for a design of engine with larger fireboxes and this demand will become more urgent if the size of our engines should be increased still more.

A Two-Hundred Foot Gantry Crane.*

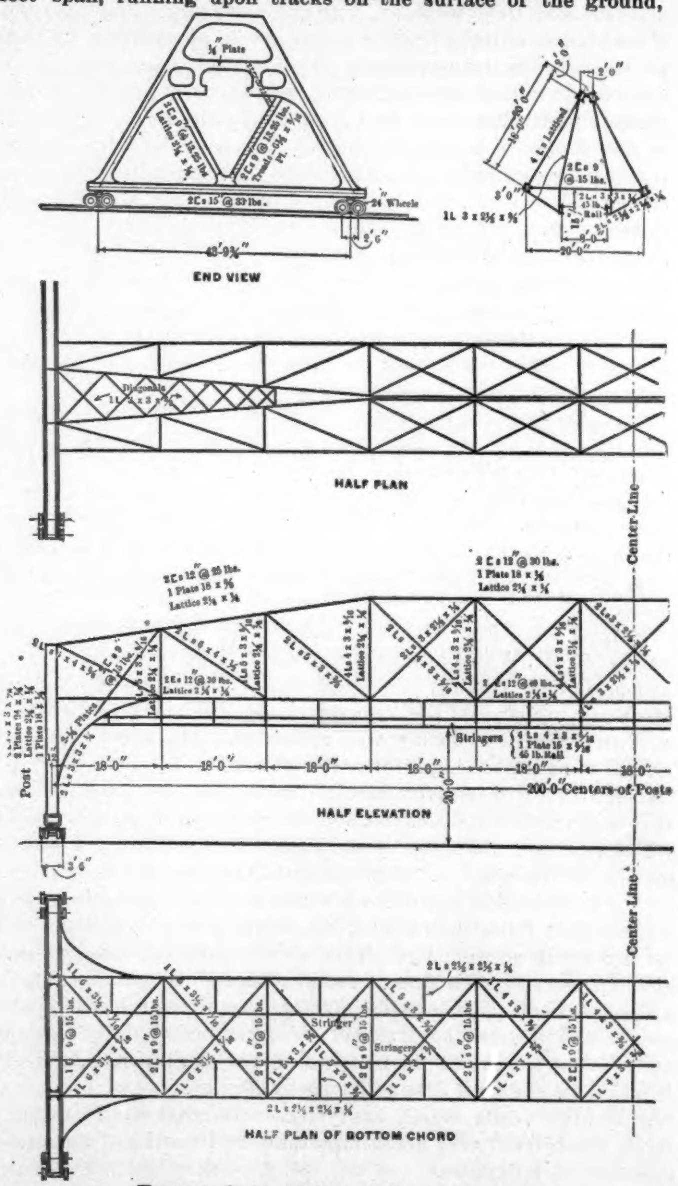
BY JOHN W. SEAVER, CLEVELAND, O.

In the latter part of the year 1895 the Cambria Iron Company, of Johnstown, Pa., decided to construct a storage and loading yard for their proposed new structural mill at Johnstown, Pa., and invited several engineering firms to submit estimates and designs for a plant to handle the material that it was intended to store and load in this yard.

Among the firms invited to submit proposals, that with which the writer is connected took up the matter at once, and gave it a great deal of very careful study. The yard it was designed to cover—400 by 800 feet—was so large that it was evident from the beginning that unless some very economical form of construction should be proposed, the expense of covering the area would be very great. There are several methods by which the desired object can be attained, and each plan was carefully considered and its objections and advantages compared.

The various systems of swinging cranes, locomotive cranes and overhead traveling cranes were all considered, but their cost and the yard space they occupied, and other objections, were deemed sufficient to cause their rejection in favor of the Gantry crane system.

This plan contemplates the use of two traveling cranes, each 200 feet span, running upon tracks on the surface of the ground,



Trusses for a 200-foot Gantry Crane.

parallel to the length of the yard, so that the two cranes cover the whole surface, with the exception of three spaces, one 5 feet wide down each outside edge of the yard, and one 10 feet wide down the center. There is one line of track down each outside edge, and two lines of track down the center.

It was proposed to mount the cranes upon end frames or legs, making them what are commonly called "Gantry cranes," and to make the legs or end supports of sufficient height to allow a train of cars, with men on top of same, to pass freely underneath. For this purpose the clear height from the top of the rail to the un-

* From a paper presented at the New York meeting (December, 1896,) of the American Society of Mechanical Engineers.

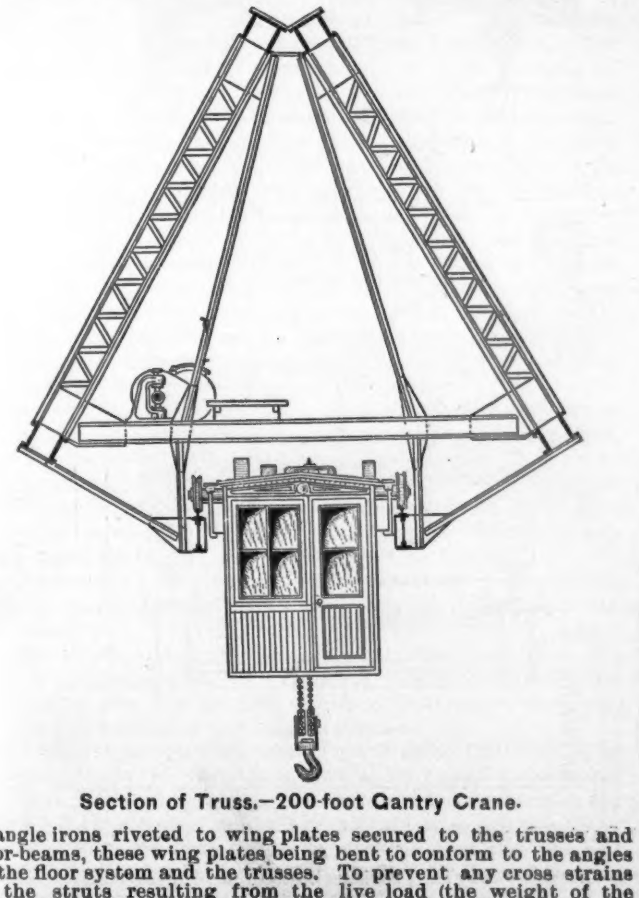
derside of the stringer that the crane trolley traverses, was fixed at 20 feet: and as the height from the surface of the yard to the top of the rail is 14⅛ inches, a clear height from the surface of the ground to the underside of the crane of 21 feet 2⅛ inches is obtained.

The magnitude of these proposed Gantries caused the matter to be most carefully considered, both by the Cambria Iron Company and the Wellman Seaver Engineering Company, who submitted this plan to them for their consideration. After a thorough examination of the plan proposed by them they were awarded the contract.

The firm decided upon a form of construction that they believe to be entirely original. It consists of two main girders of the Pratt type, with vertical posts and diagonal tension braces, the bottom chord being straight and the top chord parallel to the bottom chord for about one-half its length, and then inclining to the end posts at such an angle that the depth of truss at the ends is one-half that at the center. These two main trusses are framed together at an angle of 60 degrees. The top chords have their parallel portions connected with splice and tie plates. The bottom chords are parallel to each other and separated a distance of 20 feet. The main trusses are 18 feet deep at center and 9 feet deep at the ends. This peculiar form of construction gives the arrangement of the main tresses the appearance of a steep hipped-roof, very long in proportion to its height. A cross-section at the center is that of an equilateral triangle, and the cross-section of any point between the end posts and where the top chords join each other is that of a trapezoid.

Suspended beneath the bracing that separates the bottom chords is a runway for the crane trolley to travel on. This runway consists of riveted I-beams, with T-rails secured to their upper flanges. The stringers are very rigidly braced to the chords of the main trusses, not only at the panel points, where they were suspended, but also at the middle of each panel.

The horizontal bracing between the trusses consists of a series of floor-beams, firmly riveted to the posts of the trusses, and forming the struts of the lateral system. The diagonal members consist

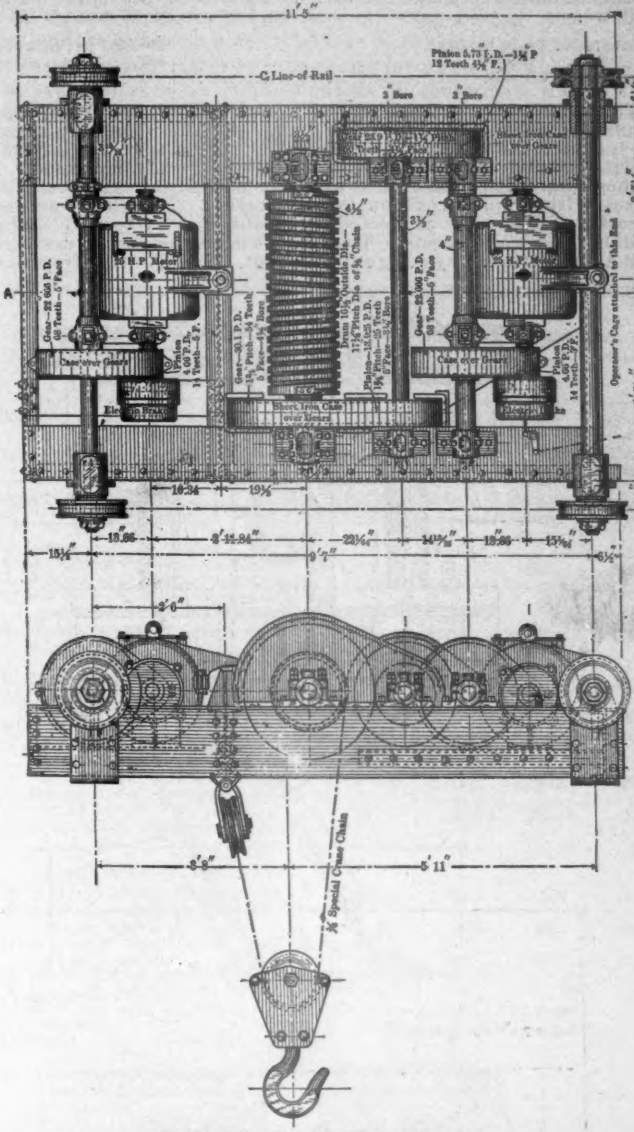


Section of Truss.—200-foot Gantry Crane.

of angle irons riveted to wing plates secured to the trusses and floor-beams, these wing plates being bent to conform to the angles of the floor system and the trusses. To prevent any cross strains of the struts resulting from the live load (the weight of the stringers and trolley), it is taken directly from the stringer suspenders up to the top of the posts of the main trusses by means of diagonal suspender angles.

Resting on top of the floor beams are two lines of channel irons parallel to the main trusses. These channel irons form stringers for the foot walk, which extends the full length of the crane. The floor beams also carry the pillow-blocks for the main shafting. At the ends of the crane, and in the plane of the trusses, are carried down riveted legs, or supports of the box form. These legs are firmly braced to the bottom chords of the main trusses, with large plate iron brackets, well stiffened with angle iron flanges. The legs are also braced to each other crosswise of the crane, with a system of horizontal and diagonal braces, with a stiff tie-beam at the foot of the legs.

The width from center to center of the trucks supporting the crane is 43 feet 9⅝ inches, forming a wheel base for the crane of a little more than one-fifth of the span, which is sufficient to square the crane on the tracks.



Trolley for 200-foot Gantry Crane.

The top chords are made of two channel irons with a cover plate on top, and latticing on the bottom. The bottom chords are made of two channel irons, latticed on top and bottom, so as to afford no room for lodgment of moisture; this point being carefully kept in view throughout the construction.

The vertical posts of the trusses each consist of four angle irons latticed together. The diagonal members of the trusses are each formed of two angle irons riveted at their intersection.

The loads and strains adopted for this crane were as follows: A live load for trolley equal to 20,000 pounds. To this was added, for impact, 25 per cent., or 5,000 pounds. The weight of the trolley was estimated at 23,000 pounds, making a total of 48,000 pounds distributed on four wheels, spaced about 9 feet centers, bringing a reaction upon each stringer support of 18,000 pounds.

To still further provide for any sudden application of a live load, it was assumed to be equal to 22,000 pounds applied at any panel point of bottom chord of each truss.

This is largely in excess of any load that will come upon the crane; but it was considered advisable to use it, in view of the fact that the load might catch, thereby bringing a greatly increased weight upon the trolley.

The dead load, weight of trusses and floor, was assumed at 88,000 pounds per truss, or 8,000 at every point of bottom chord of each truss.

In order to provide for a very large factor of safety in the bottom lateral system, a wind pressure of 20 pounds per square foot was assumed, or a load of 5,000 pounds at each panel point of bottom chord. To resist these combined loads, the following limitations of strains were adopted:

For live loads.	Tension	12,000	lbs. per sq. in. of net section.
	Shear	6,000	" " " " " "
	Compression	10,000	" of gross section.
Bearing on rivets and bolts		12,000	" per sq. in.
For dead load.	Tension	15,000	" " " " of net section.
	Shearing	10,000	" " " " "
	Compression	12,000	" " " " " gross section.
Bearings on rivets and bolts		15,000	" " " "

All of these strains are largely in excess of what the writer would recommend for an ordinary crane construction; but the ratio of dead load to live load is so great that it was necessary to observe the greatest possible economy of material to avoid the crane being so heavy that it would be impracticable.

The minimum speeds of the various motions of the crane are as follows:

Traverse of main bridge	200	feet per minute.
" trolley	400	" "
Hoist with full load	20	" "

The crane rests upon four trucks, each having four steel-tired double flange wheels, 24 inches in diameter. The wheels are keyed to steel axles, 5 inches in diameter. The gage of the track is 3 feet 6 inches centers of rails. The journals are 5 inches in diameter, 7 inches long, fitted with bronze bearings carried in cast-steel oil-boxes, with ample provision for lubrication. The wheels on one truck at each end are connected by means of a system of shafts and beveled gear-wheels. The gear-wheels are steel castings and are of extra heavy design throughout. The shafting from one truck to the other is four inches in diameter. The couplings are all rigid flanged couplings, tightly keyed to the shafts, and fitted with turned bolts of a tight driving fit. The main shaft, extending the length of the crane, is carried in universal bearing pillow-blocks of very heavy design. These pillow-blocks are bolted to the cross beams of the floor system, with packing pieces between them and the beams, and are lined up perfectly true and level. The end bearings, where the main shaft is geared to the diagonal shafts that connect it to the trucks at each end, are carried by compound boxes, so that it is impossible for the main and angular shafts to get out of line.

The top of each truck carries a steel socket or cup and in this socket is placed a hard steel ball 6 inches in diameter.

The bottom of the end supports are also provided with corresponding cupped sockets. The ball rests in a slightly elongated groove; the major diameter of the groove being crosswise to the center line of the truck, and the minor diameter being parallel to the track on which the truck rests. By means of this elongation of the groove, the ball is allowed a slight motion at right angles to the center line of the track on which the truck travels, and this permits of the expansion and contraction of the main girders of the crane. It also allows the trucks upon which the crane travels to be slightly out of alignment, as the balls form universal joints between the trucks and the crane.

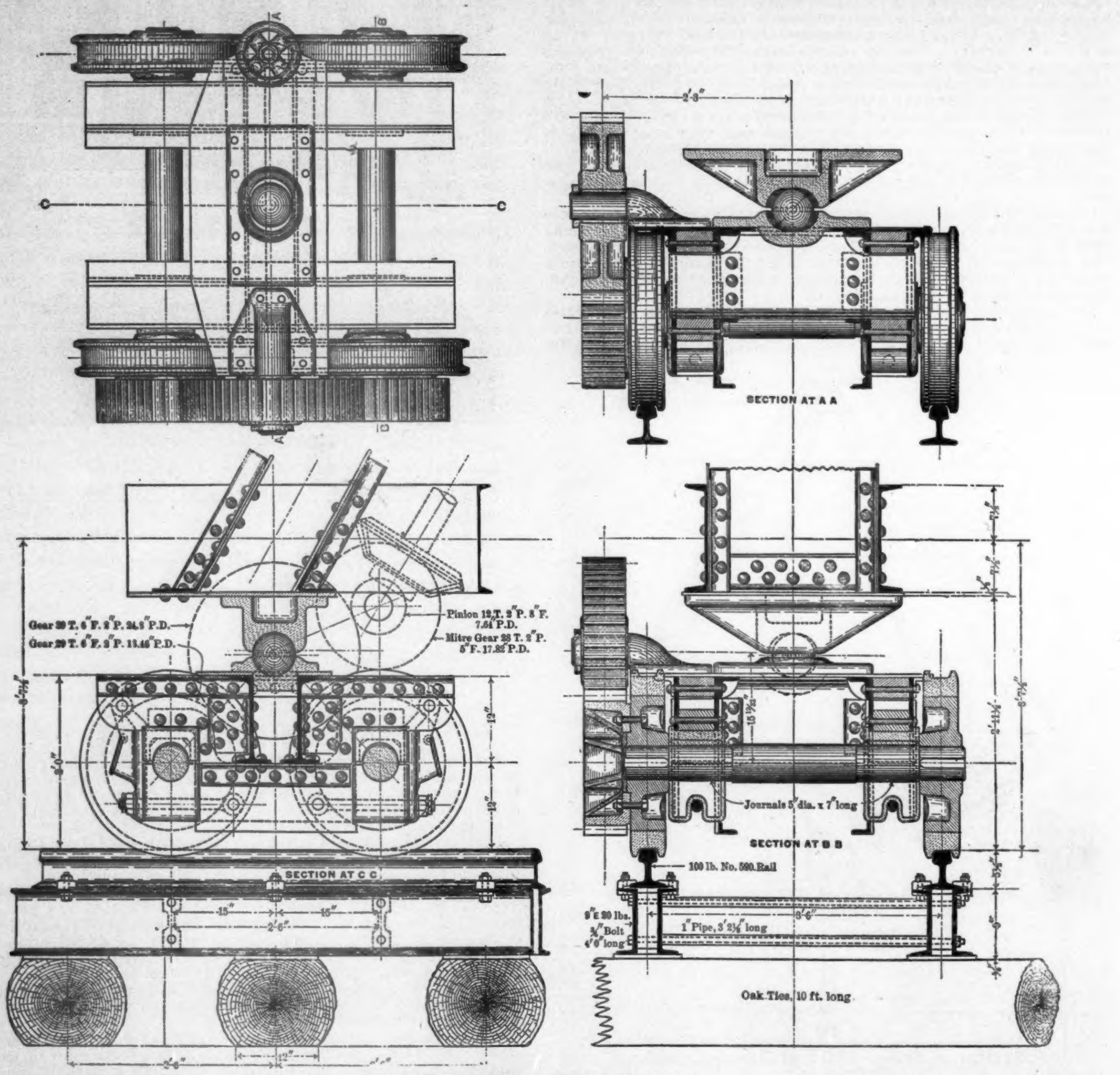
The arrangement of the gearing connecting the driving shafts to the trucks is such that the vibrations of the trucks around the centers of the balls do not disturb the alignment of the gearing to an appreciable amount as the centers of the main driving spur wheels are on the same lines as the centers of the balls.

In the center of the crane is placed a 50-horse-power electric motor, connected directly to the main shaft with one reduction of steel gearing. The trolley which travels upon the suspended runaway beneath the main chord is of the ordinary crane type, with the exception that the gearing throughout is of extra heavy design, and of either steel or bronze castings. The winding-drum is of cast iron, with right and left hand grooves for the chain, milled out of solid metal. The traversing of the trolley upon the track and the hoisting is done by two 25 horse-power electric motors. All the motors are wound for 220 volts.

The operator's cage is attached to and moves with the trolley. It is provided with windows on all sides, so that the operator can have a clear view of any part of the yard. In the cage are placed the controllers which govern all the motions of the crane, and the necessary switches, cut-outs, etc.

Attached to each truck are two snow-plows, or guards, made of plate stiffened with angle irons. These snow-plows are easily removable, so that access can be had to any part of the trucks.

The end frames are so arranged that should it be desired to transfer a load from one side of the yard to the other, both cranes can be brought in line with each other by means of removable stops on the trucks, and the trolley from either crane run directly through the end supports and on to the track on the other crane.



Truck for 200-foot Gantry Crane.

Evaporative Trials of an Almy Water Tube Boiler.

In these days when the economy of water tube boilers is called in question so vigorously by their opponents, the following report of a test made in November by Geo. H. Barnes, of Boston, on an Almy boiler in the shops of the Almy Water Tube Boiler Company, Providence, R. I., will be of interest. The boiler is one which has been in use about fifteen months, supplying steam for the engine and other purposes required in the shop. It was not cleaned or in any way specially prepared for a test, except as noted further on. From the report we condense the description of the boiler and the method of making the tests, but we give the results in full.

The boiler is of the size marked in the catalogue, Class D., in which the dimensions of the outside casing are: length, 51⅝ inches; breadth, 51⅝ inches, and height to top of casing, 78 inches. The grate is 40.1 inches long and 40.9 inches wide; and the area of the surface is 11.38 square feet. The bars of which the grate is composed are $\frac{9}{16}$ of an inch wide and separated by ⅜-inch air spaces. The number of one-inch pipes (two pipes to a section) which make up the length of the boiler, is 26, and the total exterior heating surface, without allowance for portions more or less covered and unexposed to direct heat, is approximately 474 square feet. The area of opening for draft between the tubes is 4.6 square feet. On the morning of November 2d, previous to the test of that date, it was reduced by the introduction of fire brick to one-half this area, or $\frac{1}{5}$ of the area of the grate surface. The estimated weight of iron in the boiler, not including the covering, is 3,097 pounds, and the weight of contained water at the ordinary level, 650 pounds. The stack is 19 inches in diameter, and its height above the grate is 35 feet 6 inches. The covering consists of wrought iron plates put together with angle irons, and lined with layers of asbestos and fire brick. The outside of the iron surface is unprotected. Prior to the tests, all the cracks and crevices in the covering, due to loosely fitted doors or joints, were sealed up with cement. The firedoor contains eight holes, ⅝ inch in diameter. The boiler is fed by means of a steam pump supplied with cold water. The water receives no heat on its way to the boiler, save that which comes from the coil of pipe, termed the "heater," located in the very upper part of the boiler chamber next to the stack. The steam used by the shop engine, and that required for other purposes, is less than the working capacity of the boiler, and in order to provide for suitable conditions for the evaporative tests, the surplus steam not required for the ordinary work of the shop was allowed to escape through the safety valve to the atmosphere. During the progress of the tests there was a continual discharge of steam at this point.

On the two runs with forced draft, the tests were commenced and finished under running conditions, and the condition and thickness of the fire at beginning and end were estimated. It should be stated here that these trials are of too short duration for absolute reliability as to the coal measurements. They were intended mainly to show the capacity of the boiler in horse-power under the conditions of forced draft.

The feed-water measurements, steam pressures, temperatures, quality of steam, force of draft, etc., were all determined with great care.

Samples were taken of the flue gases. On the run of Oct. 31 a sufficient number of analyses were made to secure a fair average for the entire test. On the tests of Nov. 2 the analyses were confined to a short period in each case.

The coal was sampled on each run and dried for determining moisture. On the two main trials, that is, Oct. 31, and the economy test of Nov. 2, the samples have been subjected to a heat test in the writer's coal calorimeter, and that of Oct. 31 has, in addition, been analyzed. With the data obtained from the heat test the coal analysis and the gas analysis, a complete heat balance has been drawn up for the test of Oct. 31, as appears in the tables of results. The gas analysis of Nov. 2 did not cover a sufficient period to enable the heat balance to be worked out.

At the close of the test of Oct. 31 a radiation test was made which gave a result equal to 46,477 British thermal units per hour.

The coal used on all the tests was of the same grade and class, viz., George's Creek Cumberland, obtained from R. B. Little & Company, in Providence. It was in commercially dry condition and it was fired without further wetting. On Nov. 2 the system of firing was the ordinary spreading system, the bed of coal being maintained at a thickness of 3 or 4 inches.

On a preliminary run on Oct. 30 a greater thickness of fire was maintained than that noted above, and the results of the gas analysis showed the presence of a comparatively larger amount of carbonic oxide, sometimes reaching as high a percentage of the total volume of gas as 16.9 per cent. It is interesting to note this fact, for the reason that the thickness of the fire was by no means excessive, seldom reaching more than 8 inches for the entire depth. The evaporative result obtained on this run conforms to what would be anticipated from the gas analysis, being only three-quarters of that obtained on the main tests reported in the table.

The data and results of the tests are given in the accompanying tables, of which Table No. 1 relates to the general data and results and Table No. 2 to the heat balance of Oct. 31.

TABLE No. 1.

DATA AND RESULTS OF EVAPORATIVE TESTS ON ALMY WATER TUBE BOILER AT PROVIDENCE, R. I.

Grate surface, 11.38 square feet; Heating surface, 474 square feet.

Kind of coal—George's Creek Cumberland.

Per cent. of moisture in coal	2.4	1.8	1.8	1.8
Conditions as to capacity	Normal.	Normal.	Forced draft, 1 heavy. 2 m'dium.	
Date of test—1896	Oct. 31.	Nov. 2.	Nov. 2.	Nov. 2.
TOTAL QUANTITIES.				
1, Duration— hours	9.15	6.1	.03	2.0
2. Weight of dry coal consumed, lbs	1,274.	971.	831.	543.
3. Weight of ashes and clinkers, lbs.	110.	100.	... .	....
4. Per cent. of ashes and clinkers, per cent	8. 6	10.3	....	....
5. Weight of water evaporated	11,332.	8,610.	6,560.	4,414.
HOURLY QUANTITIES.				
6. Coal consumed per hour, lbs	139.2	159.2	409.4	271.5
7. Coal consumed per hour, per square foot of grate, lbs	12.2	13. 99	35.98	23.86
8. Water evaporated per hour, lbs.	1,238.5	1,403.6	3,231.	2,207.
9. Equivalent evaporation per hour, feed 100 degrees, pressure 70 lbs., lbs	1,300.4	1,472.8	3,389.3	2,315.1
10. Horse power developed on basis of 30 lbs., H. P	43.3	49.1	112.98	77.2
11. Equivalent evaporation per sq. ft. heating surface per hour, lbs.	2.74	3.1	7.15	4.88
AVERAGES OF OBSERVATIONS.				
12. Average boiler pressure, lbs	147.1	146.8	153.6	140.1
13. Average temperature of feed water, degrees	56.7	56.6	56.	56.
14. Average temperature of flue gases, degrees	513.	473.	850.*	715.*
15. Average draft suction, inches	.12	.14	.71	.4
16. Per cent. of moisture in steam	0.35	0.4	0.72	0.42
17. Weather and outside temperature	Clear warm.	Clear mod'rate	... .	....
18. Total heat of combustion per pound of dry coal, B. T. U	....	14,168.	....	....
19. Total heat of combustion per pound combustible, B. T. U	**	15,186.	....	....
RESULTS.				
20. Water evaporated per pound of coal, lbs	8.895	8.867	7.894	8.129
21. Equivalent evaporation per pound of coal from and at 212 deg., lbs.	10.736	10.694	....	....
22. Equivalent evaporation per pound combustion from and at 212 degrees, lbs	11.746	11.922	....	....
23. Efficiency on combustible, per cent	....	75.8	....	....

*Only one observation. The actual temperature on the heavy forced draf test was higher than 850 degrees, the limit of the thermometer used—probably 900 degrees.

** See Table No. 2 for heat of combustion, computed from analysis.

TABLE No. 2 (a).

RESULTS OF GAS ANALYSIS GIVEN IN PERCENTAGES BY VOLUME.

Date, etc.	Oct. 31. Averages for whole test.	Nov. 2. One hour of main test.	No. 2, forced draft tests. 1.	2.
Carbonic acid, CO_2	13.1	10.7	13.4	12.0
Carbonic oxide, CO	0.9	2.8	1.9	0.7
Oxygen, O	4.8	5.4	3.1	5.8
Nitrogen, N	81.2	81.1	81.6	81.5
	100.0	100.0	100.0	100.0

TABLE No. 2 (b).

DATA FOR HEAT BALANCE.

Carbon in combustible		87.	per cent.
Hydrogen in combustible		4.7	"
Carbonic oxide in combustible	$\frac{.9}{13.1 + .9} \times 87. =$	5.6	"
Hot gas, not including moisture, per pound of carbon		17.95	pounds.
Hot gas, not including moisture, per pound of combustible		15.62	"
Temperature of gases above air	$513 - 72 =$	441.	degrees.
Heat in one pound of moisture in the gases		1251.	B. T. U

TABLE No. 2 (e),

HEAT BALANCE.

Total heat of combustion calculated from analysis, per pound of combustible (carbon, 82.6 per cent.; hydrogen, 4.5 per cent.; ash, 5.1 per cent.; oxygen, 4.8 per cent.; nitrogen and sulphur, 3 per cent.)............	15,169

	B. T. U.	Per cent.
1. Heat absorbed in useful evaporation—11-74 × 966 =...	11,347	74.8
2. Heat lost in hot gas—15.62 × 441 × .238 =...............	1,639	10.8
3. Heat lost by sensible and latent heat of moisture in coal and moisture formed by burning hydrogen—(.047 × 9 + .024) × 1251 =........................	562	3.6
4. Heat of combustion lost by unconsumed CO, .056 × 10,050 =...	503	3.2
5. Radiation as per test..........................	365	2.4
6. Loss from carbon in smoke, hydro-carbons in same and unaccounted for...........................	753	5.2
	15,169	

The report concludes with the following statement:

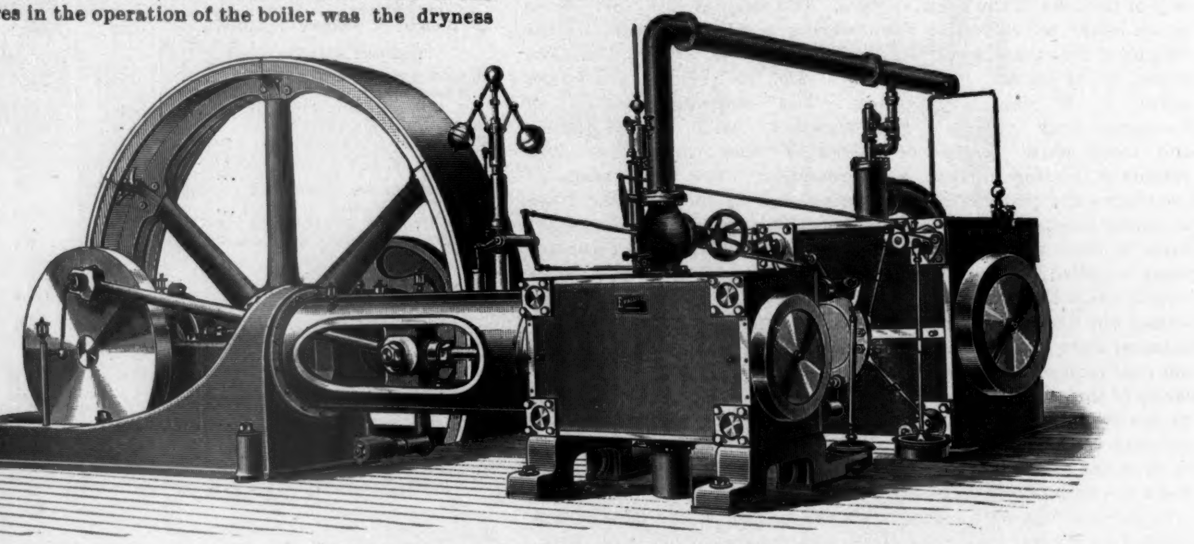
It appears from these results that, in point of economy, the boiler compares favorably with the best types. An evaporation of 11.922 pounds of water per pound of combustible, which was obtained on the test of November 2, is rarely exceeded by any form of hand-fired water tube boiler, whatever its size. One of the noticeable features in the operation of the boiler was the dryness of the steam exhibited on all the tests. Even with conditions of forced blast, when over seven pounds of water was evaporated per square foot of surface per hour, the moisture was less than one per cent. The heat balance given in Table No. 2 shows that practically all of the heat units available in the coal were accounted for, either in useful evaporation, or in chimney and other wastes.

English papers state that the French Ministry of Marine finds itself in the strange position of being unable to spend as much money as the nation wishes them to. The French nation is anxious to maintain her position as a first-rate naval power. To do so it is necessary that ships be built during the present year to the value of about five millions sterling by France, which when exerting herself to the utmost, is apparently unable to spend more than about £4,000,000 per annum on the building of new vessels, because of the slow pace at which work progresses in her ship yards. The *Engineer* says: "It is clear that other nations who either provide for themselves or purchase from others will rapidly go ahead, and France will gradually sink into the position of a secondary maritime power. There is, however, a way of escape left to the French nation. It, too, may purchase its ships abroad, and to what country can it go with more certainty of having its orders despatched with punctuality and conscientiousness than perfidious Albion?" The *American Engineer* would suggest that American ship yards can help the French nation to build its ships, and thus enable it to spend money in establishments that do not belong to its antagonists, England and Germany.

Cross-Compound "1890" Engine, Built by the Edward P. Allis Company.

The engines of various types built by the E. P. Allis Company of Milwaukee, Wis., are favorably known in every part of the world where steam power is generated and used. It has always been the policy of this company to make every engine sold a complete success from an engineering and commercial standpoint, and to this end it has employed the best of talent. This, added to their facilities for manufacturing and the superior quality of their shop work, has given them an enviable reputation and a success, which can be in part measured by the fact that in the last 20 years they have built and sold about 2,000 Corliss engines, some of them being the most notable examples of steam engineering in this country.

In the accompanying engraving we illustrate one of the cross-compound horizontal engines of the "1890" design. This engine is built in sizes ranging from 150 to 3,000 horse-power, and is looked upon as a standard for power purposes and also for electric service. For the latter work the engine is arranged to carry the electric generator mounted on the shaft alongside the fly-wheel. In that form of construction a square rimmed fly-wheel is used instead of the wide-faced wheel shown. This engine is also built as a tandem compound when desired; the economy is the same, the choice between tandem and cross-compound depending upon which is the best adapted for the available space.



Cross-Compound "1890" Engine.—Built by the Edward P. Allis Company.

The engine was designed to meet the conditions arising from the introduction of economical engines in rolling mills, and the rapid growth of electric street railway work, as well as the employment of higher steam pressures. It is peculiarly adapted to this extraordinarily trying service, and the design will commend itself to all competent to judge. The form of bed-plate is believed to be the best so far devised, giving the best possible support to the main journal and entirely eliminating all lateral strains. The parts have all been made very large, and exceed in size and weight those of any engine of like size cylinder manufactured. The company guarantees these engines to operate continuously under a steam pressure of 150 pounds per square inch, and in any service.

The valve gear used on the engines was introduced in substantially its present form by Mr. Reynolds in 1876. Its action is perfect, imposing little or no work on the regulator, thereby securing the closest regulation, and it can be operated at speeds usually deemed impracticable with a drop cut-off gear.

All materials used in the construction of these engines are subjected to rigid physical tests under the direction of competent engineers. The requirements are the same as exacted by the United States government and the leading railroad companies. The cylinders are made from carefully selected iron, remelted, as experience has shown that the most durable cylinders are not necessarily the hardest, but the cleanest. The purer the iron from which they are made the better the cylinders will wear. The company selects a variety of irons best adapted to the purpose, a considerable portion being charcoal irons, and these are melted and run into pigs. From these pigs remelted, the cylinders, valves and piston packing rings are cast. This process insures exceptionally fine castings, and the increased durability of the cylinders warrants the additional expense.

Equal precaution is observed in the selection of irons used in balance wheels; and to this, as well as excellence of design, is due the fact that of many hundreds of wheels of all sizes up to 40 feet in diameter, made at these works, not one has proven defective in practice.

The care bestowed on the selection of iron for use in cylinders and wheels is extended to all parts of the engine where castings are employed, each part being made of such irons as experience has proven best for the particular purpose. Bronze castings are used for valve stems and all other places where that metal is required. Piston rods, connecting rods, crank and cross-head pins are made of steel. Hammered iron is used for the main shafts. All bolts and studs about the engine are made of double-refined iron or mild steel. The main journal bearings, cross-head shoes and crank-pin brasses are faced with genuine babbitt.

Many notable engines of this type have been built by the company. The power plant of the Brooklyn Street Railway Company might be mentioned. It consists of six engines, with a rated capacity of 2,000 to 3,000 horse-power, and eight engines, rated at 1,000 to 1,600 horse-power. In the works of the company there are now under construction three of these engines, each of 1,200 horse-power, for one of the large mining companies near Johannesburg, South Africa, and another order of these engines has just been shipped to South Africa.

The special engines built by the company are numerous, and like this standard type illustrated, are sent to all parts of the world.

Arbitration Committee Decisions.

At a meeting of the Arbitration Committee of the Master Builders' Association, held Dec. 16, 1896, the following subjects were considered worthy of a ruling:

When scrap credits are allowable the weights credited should always be equal to the weights of the new metal applied, except as otherwise provided in the Rules and in Section D of leaflet No. 1, Sept. 16, 1896.

Several inquiries as to the meaning of the words "switching roads," in Section 25 of Rule 5, were considered, and the committee makes the following ruling as a definition of a switching road as used in this connection: A switching road is a corporation doing the major part of its business on a switching charge, or one which does not pay mileage to car owners for the use of the owner's car.

The Cost of Armor Plate.

On Jan. 5 Secretary Herbert sent to Congress a report on the cost of armor plate that has created considerable of a sensation. Last summer Congress passed a resolution authorizing an examination into the actual cost of armor plate, and a recommendation as to the price for armor that would be equitable. This report of Secretary Herbert is the result. In making his investigation the Secretary classed the sources of information and their availability as follows:

"1. The contractors for armor. They, of course, could, if so disposed, give me full and accurate information as to the cost of their plants and of the manufacture of armor.

"2. The naval officers who had been stationed at the works of the armor manufacturers as inspectors. These officers did not have access to the books of the contractors and could not be expected to give very accurate information as to the cost of the plant, but they had opportunities to know about the cost of material and the character and amount of labor employed.

"3. The prices of armor abroad, though already known in great part, could be more thoroughly inquired into and compared with the prices being paid by the government.

"4. The cost of erecting the armor plants, which was a material portion of the inquiry, could not be ascertained with absolute accuracy without an inspection of the books of the contractors. If they should fail to furnish the proper information, an inquiry into the price at which similar plants could at present be erected would throw light upon the subject. This inquiry into the present cost of erecting armor plants seemed to be all the more material because the Naval Committee of the United States Senate, when it began the investigation which resulted in the enactment of the law calling for this report, had before it the proposition that the government itself should erect a plant for the purpose of manufacturing its own armor.

"5. Search should be instituted for any reports made by the two contracting companies under the laws of their State to State authorities."

The first mentioned source of information did not yield any figures at first, but after the investigation had made considerable progress along other lines, the Carnegie and Bethlehem companies wrote letters to the Secretary giving some information, and at the same time protesting against disclosing business secrets to competitors. In the letter of the Bethlehem Company the cost of the material and labor involved in the manufacture of one ton of armor is placed at $250. To this they add $78 per ton interest on $4,000,000, the cost of their armor plant, $132 per ton depreciation and maintenance (at the rate of 10 per cent.), and $33 per ton interest on a working capital of $1,500,000. This makes a total of $493 per ton without including administration expenses, cost of experiments, rejected plates, &c. The letter of the Carnegie Company protests that the estimates of naval experts omit interest on the cost of their plant valued at $3,000,000, this interest amounting to $81.53 per ton; maintenance on the plant, $67.94 per ton; loss by abandonment of plant when navy shall have been completed, say ten years from date, $75.49 per ton; or a total of $224.96 to be added to the cost as given by the naval experts.

Turning to the estimates of the costs of plants made by the government inspectors, we find that Ensign McVay in his statement of the plant at Carnegie's estimates the amount at $3,000,000. In that amount he includes $300,000 for stock in hand, and items for land, light and power which aggregate $775,000, or, including the stock item, a total of $1,075,000. Deducting this sum from the $3,000,000 leaves $1,925,000 as the cost of the plant without ground, power or light. The company claim, however, that the cost was $2,500,000 exclusive of the items of ground, railway connection, water plant, power and light plants, these being taken from their other works.

The Rohrer board estimated the cost of the armor plant of the Bethlehem Iron Company at $4,881,000, or $881,000 more than the amount on which the company figure interest in their estimates. There is no doubt but that the Bethlehem plant did cost more than the Carnegie. The Secretary believes that it would not be unjust to allow in the estimates $1,000,000 more for the plant at Bethlehem than for that at Carnegie's.

During the Secretary's visit to Europe he procured two estimates of the cost of armor plants.

"One of them was made in England by a company which is prepared to furnish the plant. This estimate by a manufacturer of experience and reputation puts as a sufficient sum for machinery £113,400, but it having been referred to the Chief of the Bureau of Ordnance to be completed by adding estimates for duties, buildings, installation, etc., he has added these and other costly items which he deems necessary to make it equal the American plants. As thus completed it amounts to $1,590,000. This is the estimate for putting up complete a plant equal to that of the Carnegie Company, said to have cost $3,000,000. Prices are, however, lower now than in 1887, when the Bethlehem Company began their plant, or even than in 1890, when the Carnegie Company undertook the manufacture of armor."

Secretary Herbert then describes the formation of a board consisting of Lieutenants Rohrer, Niles and Ackerman, which was instructed to make a careful estimate of the actual cost in labor and material for the manufacture of armor. This board reported that the cost of labor and material in a ton of single forged Harveyed nickel steel, the government supplying the nickel, was $167.30. An allowance of 10 per cent. for rejections and $11.27 per ton for reforging brought the cost of reforged armor up to $197 per ton. This, the Secretary states, is a very liberal estimate to the contractor.

The Secretary then proceeds to estimate the profits of the two companies on their armor plate business from the time their plants went into service until June 30, 1897, and he reaches the conclusion that in the case of the Bethlehem Company, the earnings of the plant are sufficient, "after paying 22 per cent. on all money put into new plants from date of issue of stock and until its cancellation, to repay their stockholders in full and accumulate a surplus of $1,434,222, sufficient to more than pay off their bonded debt of $1,351,000. These calculations above show net results: only net earnings have been considered and the results show that company's investments in plant to make armor and gun steel for the government have returned 23 per cent. thereon."

The basis of the above estimates is the reports made by the company to the Auditor-General of Pennsylvania.

There were no such reports from the Carnegie Company and the estimates regarding the latter company's business have, therefore, been based on the best available information as to the value of their plant and the cost of manufacture of the armor. This plant has not been in operation as long as the Bethlehem plant, but from June 30, 1892, to June 30, 1897, the Secretary estimates that the profits have been and during the next six moths will be under existing contracts, sufficient to pay five per cent. interest on $750,000 working capital, five per cent. maintenance annually, ten per cent. dividends and to practically extinguish the entire first cost of the plant ($3,000,000) by the surplus accumulated.

The Secretary next takes up the question of what would be a fair price for armor. He says in part:

"What, then, will be a price sufficient to justify manufacturers in maintaining armor plants? These two contractors, we have seen, have already been repaid the cost of their plant, together with fair profits thereon. It has been determined that the cost of the labor and material in a ton of double forged nickel steel Harveyed armor, including allowances for losses in manufacture, is $196.45. This comprises every element of cost in its manufacture save and except only the maintenance of plant. I allow in this calculation 10 per cent. for maintenance.

"The present value of an armor plant like those of the companies referred to—the price at which such a plant could be erected—is, according to the figures heretofore attained, $1,500,000: the allowance for maintenance, $150,000 per annum while the plant is in operation. If we suppose that 2,500 tons of armor are manufactured per annum, this will give an average per ton of $60, which, being added to the cost of labor and material, will make in round numbers $256. If 3,000 tons per annum are manufactured the price of each ton would be ascertained by adding $50 to the $196, or $246, so

that we may take $250 in round numbers as the cost of a ton of armor when the companies have fair orders for work."

The Secretary then takes up the Bethlehem contracts for armor for Russia and shows that the price in the first order, $249, is close to to the estimates of the actual cost of armor. If with freeght charges and the cost of nickel added, it led to the conclusion that the order was filled at a loss, the next order of 1,137 tons at $520.70 per ton shows the profits the company expected to realize in the European markets. "If there was no loss in the first contract at $249, there was an immense profit in their next contract at $520.70. If there was a loss on each of 1,400 tons (the first order) it could not have been very great or the company could not expect to recoup except by reasonable rates on large contracts, which they could have little reason to expect in Europe."

"It is essential, as has already been stated, that these or other armor plants be kept in operation, or at least be maintained in readiness for government work, and such prices must be paid as will satisfy contractors that they will be remunerated for maintaining plants.

"It therefore seems to me that under all the circumstances, considering the uncertainty of future contracts and in view of the fact that these contractors have heretofore established plants on the faith of orders they were to receive thereafter from the government, it would not be inequitable to allow them 50 per cent. upon the cost of manufacting armor for the three ships now under contract. Fifty per cent. added to $250 would be $375, but it is to be remembered that the government has heretofore furnished the nickel, and that the item of $196 for labor and material does not cover the cost of the nickel.

"It is, therefore, suggested that in future contracts manufacturers shall be required to furnish their own nickel. Adding $20 for this item to $375 we have $395 per ton, and allowing something for keeping nickel on hand, we have in round numbers $400 per ton. This seems to be a fair and equitable price to pay for armor for the *Wisconsin*, *Alabama* and *Illinois*.

"If Congress at this session should authorize two or more battleships, I would suggest as a price to be paid for the armor of these and the foregoing battleships $375 per ton. Upon the larger order the contractors could well afford to allow a reduction of $25 per ton.

"I may be possible that the contractors may refuse to accept contracts at the price herein recommended. If Congress should determine that these prices, or any other, are fair and equitable, and shall decide not to pay any more, it should determine upon the course it will pursue in case the contractors refuse to accept its conclusions.

"I recommend that if Congress shall determine by law upon any limit of price to be paid, it shall also authorize the Secretary of the Navy to erect or buy an armor plant, and a gun plant, and if need be to lease such plant or plants until it can construct its own."

Electric Power Transmission to Buffalo.

On Jan. 12 there was a banquet in Buffalo, given by the Cataract Power and Conduit Company to eminent business men and engineers in celebration of the transmission of electrical energy from Niagara Falls to Buffalo. Nearly 400 guests were present. Among the addresses was one by Mr. Stetson, one of the directors of the company, in which he gave some interesting facts bearing on this great enterprise. Regarding their franchise he said that it required that on or before June 1, 1897, the company should be prepared to supply 10,000 horse-power to consumers within the city, and with this condition the company has so far complied that upon the first day of December, 1896 (six months before the specified date), it introduced into the city of Buffalo 1,000 horse-power, which from that time on has been satisfactorily employed by the enterprising, intelligent and public-spirited directors of the Buffalo Street Railway Company, to whose justifiable confidence in the sufficiency and continuity of Niagara power the city of Buffalo is indebted for this early introduction.

"It is, however, proper to observe that a reasonable postponement of the date before which the remaining 9,000 horse-power shall be required to be ready for use in this city will be necessary. It is entirely credible that, like the business men of every other city of the United States, the citizens of Buffalo found the spring and summer of 1896 exceptionally unfavorable for the promotion or prosecution of business enterprises involving novel elements, or calling for the expenditure of considerable sums of money. But whether or not this were so in Buffalo, it is true that during the year 1896, and prior to Nov. 4, few corporations undertook or accomplished in the way of new construction more than did the Niagara Falls Power Company and the Cataract Power and Conduit Company in the installation of the line for generating and transmitting the Niagara Power now in use in the City of Buffalo. Naturally enough, all desired that such installation should be established with such care as to avoid, so far as possible, the chance of failure and disappointment in operation, and, therefore, it was deemed best not to provide all the new machinery required for 10,000 horse-power until after the actual test of the transmission of the 1,000 horse-power, for the delivery of which upon Dec. 1 Mr. Littell contracted in August, 1896.

"The actual test having been made with results wholly satisfactory, the Niagara Falls Power Company now has concluded its contracts for the immediate generation of not merely 10,000 but of 25,000 additional electrical horse-power, of which as much as required will immediately thereupon be available for transmission to Buffalo. The contracts for this purpose have been actually assented to, and the money therefor has been actually provided.

"The contract for an extension of the wheel pit sufficient to receive all the machinery for 50,000 electrical horse-power was made in 1896, and work thereunder has been and now is proceeding with the stipulation for its completion during the month of May, 1897."

Hill Climbing with 22 by 28-inch Consolidation Engines.

Mr. Harvey Middleton, General Superintendent of Motive Power of the Baltimore & Ohio Railroad, has recently tested the Pittsburgh Consolidation Engines Nos. 1628 and 1624, on Cranberry grade. These engines are among those recently delivered to the company. From Mr. Middleton's report we take the following:

"On Dec. 3, 1896, a trial of the two 22 by 28-inch Pittsburgh Consolidation Engines Nos. 1628 and 1624 was made on the Cranberry grade. Engine 1628 at the head of the train was run by Engineman P. J. Moran, with engine 1624, Engineman S. H. Dunning as helper. Engine 1628 was run through from Cumberland to Rowlesburg, where the fire was cleaned at front end and the old sand removed from the sand-box and the box filled with sharp river sand. Engine 1624 also had its box filled with this sand.

"The train consisted of 24 hopper gondola cars and a caboose. The gross weight of train, exclusive of caboose, was 2,046,699 pounds, or 1,023 tons; with caboose, 11 tons additional, or 1,034 tons. Gross weight of train, including engines and caboose, 1,202 tons. The rise of the grade is 116 feet per mile, with numerous curves. In the construction of the road no diminution of the grade was made at the curves to compensate for the additional resistance, and consequently it is much more severe than the figures, 116 feet to the mile, would indicate. The usual running time of a train over this grade is between two and three hours.

"The day was clear and cold. The train started from coal chute at Rowlesburg at 1:29 p. m., and arrived at Terra Alta at 3:05 p. m., a distance of 12.3 miles in 1 hour and 36 minutes. Of this 13 minutes was consumed at No. 42 Water Station, leaving a net running time of 1 hour and 23 minutes. The steam pressure on the forward engine was 180 pounds, the pop blowing off all the way up the hill; the helping engine had a pressure of from 170 to 180 pounds, most of the time from 175 to 180. Engine 1628 slipped her wheels only about 6 revolutions during the trip up the hill; engine 1624 not at all, nor was it necessary to relieve the cylinders by opening the cylinder cocks in starting the train. The start was good and strong, without any slipping of the wheels such as is usually experienced in starting a train on this grade. The injectors were feeding the boilers all the way up the hill on both engines.

"Engine 1628 took the train from Terra Alta east, leaving Terra Alta at 3:31 p. m. and arriving at Altamont at 4:23 p. m, a distance of 18.8 miles in 1 hour and 2 minutes. It left Altamont at 4:32 p. m. and arrived at Piedmont at 5:30 p. m., making the distance from Terra Alta to Piedmont, 35.6 miles, in 2 hours and 9 minutes. The total distance from Rowlesburg to Piedmont, 47.9 miles, was made in 3 hours and 32 minutes."

Engineers' Club of Cincinnati.

The ninth annual meeting of the club was held on Dec. 17, at which time the following officers for 1897 were elected: President, Chas. F. Lindsay; Vice-President, G. W. Kittredge; Directors, W. B. Ruggles, A. O. Elzner, S. Whinery; Secretary and Treasurer, J. F. Wilson.

Civil Engineers' Society of St. Paul.

A regular meeting of the Civil Engineers' Society of St. Paul was held on Jan. 4. The annual election resulted in the following list of officers for the year 1897: President, K. E. Hilgard; Vice-President, Oliver Crosby; Secretary, C. L. Annan; Treasurer, A. O. Powell; Librarian, A. W. Münster; Representative on the Board of Managers of the Association of Engineering Societies, E. E. Woodman.

A Large Carbon Steel Plate.

The works of the Carbon Steel Company, Pittsburgh, are fully equipped with modern machinery, and the excellence of the material turned out by this company is attested by the frequency with which it is specified in locomotive and other boiler work. Their machinery is large enough to turn out plates of great size, an example of which are a number of firebox plates 196 inches by 114½ inches by $\frac{3}{16}$ inch, rolled by them. A more remarkable plate is a test plate rolled for the United States Government. It is 152 inches by 114½ inches by $1\frac{7}{16}$ inches. This plate weighs 7,200 pounds and was made to a very rigid specification and one not easy to fill. The tensile strength was to be 65,000 pounds, and two test pieces gave 67,680 and 65,200 pounds, respectively, the elongation of the former being 24.7 per cent. and of the latter 25 per cent. in 8 inches. A transverse test piece was bent over close on itself without a sign of fracture. The chemical analysis of the plate gave the following result;

Carbon	.31
Manganese	.35
Phosphorus	.029
Sulphur	.023

The government specifications called for 24 per cent. elongation in longitudinal specimens, 22 per cent. in transverse specimens, and that the latter should bend double over a mandril $1\frac{3}{16}$ diameter. The plate more than met the requirements in every particular. The ability of the company to turn out such a large boiler plate of so excellent a quality demonstrates the capacity of its plant and the excellence of its processes and general product.

An Improved Air Hoist.

The straight lift pneumatic hoist shown in the accompanying engraving is of improved construction, and built by the Pneumatic Engineering Company of 100 Broadway, New York City. In the smaller sizes, seamless drawn brass tubing is used for making the cylinders, while for those of larger proportions and a greater length of lift, seamless drawn steel tubing is employed. In some special cases the cylinders are constructed of cast iron. A hoist giving a 4-foot lift is the size used in most shops. They are, however, furnished with a length of lift ranging all the way from 3 to 20 feet, and a capacity of from 200 to 20,000 pounds.

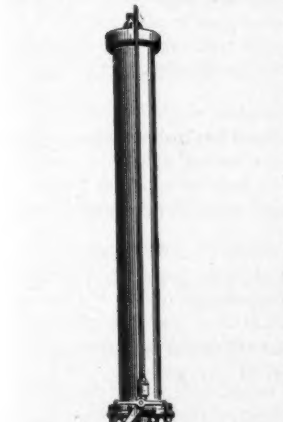


Fig. 1.—An Improved Air Hoist.

A good feature of the hoist which we show is the attachment of the air valve to the cylinder, instead of to the lower head, as is the usual practice. This admits of the head being removed the same as a steam cylinder cover, and without disconnecting the air pipe or detaching the cylinder from the trolley or crane. The hook, which carries the load hoisted, is swiveled to the lower end of the piston rod in such a manner as to require the least possible amount of room. This is an advantage worth considering where head-room is limited. The piston rod is fitted with a gland containing a packing and requires practically no attention beyond being oiled occasionally.

One of the most important features of hoists of this class is the air valve. In the lift shown the valve is a model of simplicity in its construction, and we are informed is very reliable and economical in its working. Air is admitted to the hoist by the movement of a lever in one direction and exhausted by reversing it. Regulation can be secured from a scarcely perceptible motion of the piston to full speed at will. It is a lift valve provided with a soft rubber seat, in consequence of which it will not leak with wear, neither will dust or dirt keep it from closing tightly. Ready access for examination is provided. The valve closes automatically, holding the piston at any point desired whenever the operating lever is released. The result is a great saving in air compared with hoists having valves which must be closed by hand.

The area over which these hoists can be operated is almost unlimited, and is accomplished by means of a quickly operated hose coupling valve, and by having live air drop-hose connections in convenient places, or wherever there is lifting to be done.

Horizontal hoists are fitted either with or without multiplying sheaves, according to circumstances, and in some cases they are

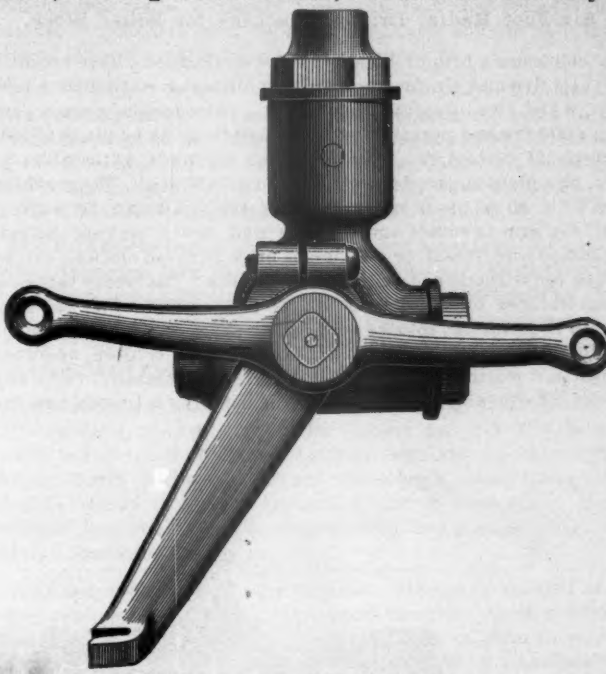


Fig. 2.—Improved Air Hoist Valve.

made to telescope, thus securing a high lift with a short cylinder. These patterns are necessarily more complicated and expensive than the straight lift style and should be used only where sufficient head-room cannot be obtained for the usual pattern.

This improved air hoist is well adapted to take the place of chain blocks and hand cranes of all kinds, and is used very generally in machine shops, architectural iron works, boiler shops, bridge works foundries, power stations, etc., etc. As a foundry hoist its use enables the molder to open his flasks without other help.

The Sargent Company's Steel Castings.

We mentioned last month the excellence of the steel castings being turned out by the Sargent Company, of Chicago. We present herewith two tables, the first of which gives the physical properties of their open-hearth castings as evidenced from six heats, while the second table compares the qualities of their open-hearth steel with the U. S. Government specifications:

TABLE 1.—PHYSICAL PROPERTIES OF THE SARGEANT COMPANY'S OPEN HEARTH STEEL CASTINGS.

Heat No.	Tensile strength per square inch.	Per cent. elongation in 8 inches.	Reduction of area.
E 138	67,800	22.5	41.5
E 141	60,200	24.8	46.6
E 142	64,700	23.3	44.7
E 144	59,300	24.8	46.9
E 149	60,500	26.2	45.4
E 154	62,200	25 5	52.5

TABLE 2.—SARGEANT COMPANY'S STEEL CASTINGS COMPARED WITH U. S. GOVERNMENT SPECIFICATIONS.

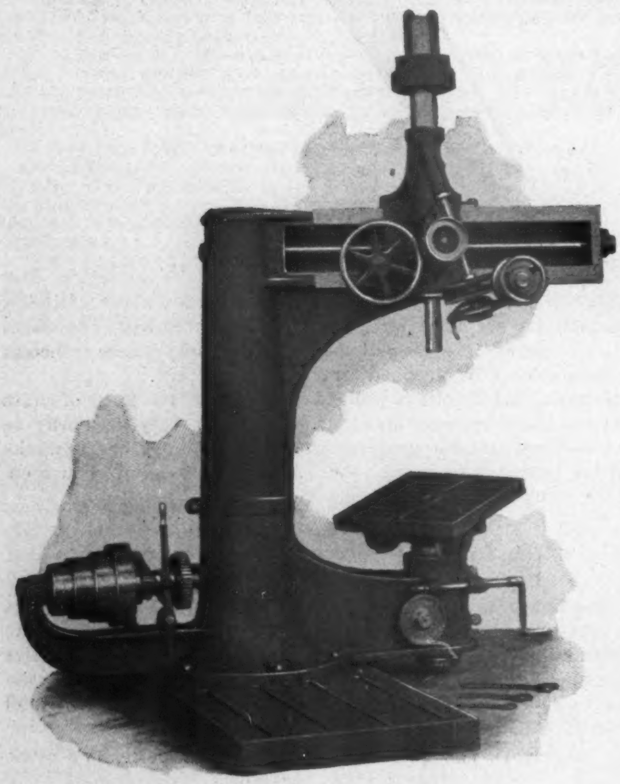
Physical properties.	U. S. Government Specifications.	Sargent Company's averages.
Tensile strength, pounds per square inch.	60,000	62,450
Per cent. elongation	in 2 inches, 18.	in 8 inches, 24.5
Per cent. reduction of area	not specified.	46.3
Per cent. phosphorus	under 0.06	under 0.04

The company has been doing an excellent business with railroad companies in furnishing them steel castings. As an illustration, in

some of the latest Rock Island engines there were 21,573 pounds of steel castings used per engine and all of these except the frames were furnished by the Sargent Company. The order included driving boxes, foot-plates, engine truck center plates or "spiders" and driving wheels. The saving in the weight of the four driving boxes was 472 pounds, foot-plate, 549 pounds; engine truck center, 631 pounds; and the saving in the weight of driving wheel centers was as usual very large.

A Six-Foot Radial Drilling-Machine for Boiler Work.

The well-known firm of Bement, Miles & Company have recently built their five and six-foot radial drills for boiler work from a new design, which we illustrate herewith. This design gives a very strong machine and permits several variations to be made to suit the needs of customers. The table can be made adjustable, as shown, or a plain square box table can be substituted. The machine can be built as a plain radial drill or the head can be made to swivel, the arm to rotate and to raise and lower, making the machine entirely universal, or any one or more of these motions can be provided for without necessitating the others. The sleeve carrying the arm rotates on steel balls to reduce friction. The table, as shown in illustration, rotates on its axis, has a vertical adjustment of 10 inches by a circular rack on the supporting column, operated by worm and worm wheel, and can be set horizontally, vertically or at any intermediate angle. When the machine is to stand on the



A Six-Foot Radial Drilling Machine.

ground floor, the circular rack can be lengthened, as required, to give an increased vertical adjustment to the table.

Like all the other tools made by this company, the best of workmanship and materials enter into their construction. The drills are built in sizes, from 4½ feet to 10 feet, the size indicating the distance from the center of the column to the end of the arm. Some particulars of these sizes are given in the following table:

Feet.	Will drill in center of circle.	Greatest distance spindle to		Traverse of spindle.
		Base plate.	Table.	
4½	81 in.	52 in.	28 in.	12 in.
5	90 "	57 "	37¾ "	14½ "
6	110 "	67 "	40½ "	18 "
7	138 "	66 "	40 "	20 "
8	156 "	64 "	....	18 "
10	200 "	83 "	....	21 "

The main office of the company is at the works in Philadelphia. It also has a New York office at 39 Cortland street, and a Western office at 1534 Marquette Building, Chicago, Ill.

A Large Electric Line Projected.

Articles of incorporation have been filed with the Secretary of State of Ohio for what will be the biggest electric railroad system in the world, if the scheme is carried out. The articles were filed by Hon. Harry Probasco, as counsel of the company, and the charter was issued without delay. The project contemplates the making of an electric road of the entire Cincinnati, Hamilton & Dayton Railway system between Cincinnati and Toledo and also between Dayton and Ironton. The new company is to be known as the C., H. & D. Traction Company, and under the articles of incorporation it is authorized to lease, own, acquire, build, operate or maintain, either alone or in conjunction with any other street, surburban, interurban, or other railway company of street, surburban or interurban railways, to be operated by electricity, steam or any other motive power, to do a freight and passenger business. The capital stock of the company is $50,000, in $100 shares. The incorporators are C. G. Waldo, D. G. Edwards, Geo. R. Balch, R. P. Rafenberick and C. A. Wilson. The capital stock of the company, while small, it is expected will be enlarged very materially at a later date, the object being for the first operation to equip the line between Middletown and Hamilton, which can be done at a very small expense, the track and roadbed being all complete. From the experience acquired in this initial plant, it is said the development of the line of the C., H. & D. Ry. between Cincinnati and Hamilton and other points will be carried on.

EQUIPMENT AND MANUFACTURING NOTES.

The Northern Pacific is figuring on new passenger equipment for spring delivery.

The C. & E. I. Railroad is asking bids on from 250 to 700 coal cars, of 40 tons capacity.

The Baldwin Locomotive Works have delivered six new engines to the Union Pacific, Denver & Gulf.

The Missouri Car and Foundry Company's Works at St. Louis, Mo., were damaged by fire on Jan. 2.

The Berwind-White Coal Mining Company has ordered 150 freight cars from the Middletown Car Works.

The Chicago & West Michigan has placed an order for one engine with the Baldwin Locomotive Works.

The Midland Terminal Railroad has placed an order for five locomotives with the Schenectady Locomotive Works.

The Bath Iron Works, Maine, have been awarded a contract for two lightships and one lighthouse tender, to cost $320,000.

The ten locomotives for the Kansas City, Pittsburgh & Gulf Railway have been placed with the Baldwin Locomotive Works.

The Wells & French Company is building 300 cars for Armour & Company, of Chicago, of which 200 are fruit cars and 100 are for beef.

Mr. Geo. W. Ristine, Receiver and General Manager of the Colorado Midland, has ordered 180 box cars from the Pullman Company.

The St. Charles Car Company are building 100 new coal cars for the Union Pacific, Denver & Gulf, which are to be equipped with the Selden coupler.

J. A. Ellis, whose office is in the Monadnock Block, Chicago, has been appointed Western agent for the Dickson Manufacturing Company, of Scranton, Pa.

The Weimer Manufacturing Company, of Lebanon, Pa., have orders from the Carnegie Steel Company for 16 steel cinder cars for the Edgar Thompson Works.

The Ross-Mehan Foundry Company, of Chattanooga, Tenn., is building additional furnaces in its malleable department, by which its capacity will be doubled.

The National Electric Headlight Company, of Indianapolis, has received an order for three more electric headlights from the Texas Midland road, where seven are now in use.

The Ohio Falls Car Manufacturing Company will build for the Charleston & Western Carolina Railway 375 freight cars, 10 cabooses and 15 or 18 passenger and baggage cars.

The Consolidated Car Heating Company has recently equipped the private car of President Blair, of the Wheeling & Lake Erie Railway, with its standard drum steam-heating system.

The Lebanon Manufacturing Company, of Lebanon, Pa., have an order from the Cornwall & Lebanon Railroad to equip with air-brakes and automatic couplers 200 freight cars recently repaired.

The Mack Injector Company will remove to Lynn, Mass. The company have been located in Boston. They manufacture steam injectors for locomotives and do a general line of machinery business.

The Morgan Engineering Company, Alliance, O., have received a contract from the government for nine Buffington-Crozier model of 1894 gun carriages. The contract calls for the completion of the carriages within one year.

The Mason Regulator Company, Boston, Mass., have a contract for about 25 reducing valves, for the Liondale Dye, Bleach and Print Works, Rockaway, N. J.; also all the pressure regulators for their pumps, and a hydraulic damper regulator for the boilers.

McKee, Fuller & Company, through their Western agent, Mr. J. L. Woods, have just sold 70 36-inch coach wheels to the Chicago, Rock Island & Pacific Railroad, for replacements, and 160 locomotive truck wheels to the Chicago, Milwaukee & St. Paul Railway.

The 180 freight cars which have been ordered by the Colorado Midland Railway will be equipped with the American Steel Foundry Company's bolsters. This company's bolsters will also go under 163 refrigerator cars being built for the Armour Packing Company.

The Hancock Inspirator Company announces to its patrons and the trade in general that on and after January 1, of this year, it will conduct the sale of its goods direct. All orders will receive proper attention and prompt shipment. Prices and discounts will be quoted upon application.

The Falls Hollow staybolts have been specified by Mr. R. H. Soule, Superintendent of Motive Power of the Norfolk & Western Railway, for the seven consolidation engines building for that road, the bolts to be used in such portions of the side sheets as are subject to the greatest strains.

The Kansas City, Pittsburgh & Gulf Railroad has placed an order with the Barney & Smith Car Company for 100 box cars. These cars are to be equipped with the Chicago roof, Tower couplers and Pickering springs, and it is probable that the road will order at least 1,000 cars during the coming year.

H. K. Porter & Company, of Pittsburgh, are building two compressed-air locomotives of 18-inch gage, one for a copper mine in Montana and the other for a silver mine in Idaho. A test of a similar motor was made recently with and without reheater, and it is said to have given very satisfactory results.

The Mexican Central Railway has prepared specifications for 570 freight cars, of which 350 are to be box. It is understood that the specifications will be submitted for proposals within the next two or three weeks, and that the order will be awarded on the return of President A. A. Robinson from Europe in February.

The Henry R. Worthington Company, manufacturers of pumping machinery, have received word that the exhibit of Worthington pumps at the Hungarian National Exhibition, at Budapest, has been awarded a grand Millennium medal. This medal is the only award made for pumping machinery at the exhibition.

The Dickson Manufacturing Company, Scranton, Pa., is building a double pumping engine for the city water-works of New Bedford, Mass. It is also building large sluice gates for a drainage canal in the City of Mexico. It also has considerable work for the Calumet & Hecla Mining Company, and a contract for six locomotives.

Recent sales of the Beaudry Champion power hammer have been made by Beaudry & Company, 162 Commercial street, Boston, Mass., to B. & S. Massey, Manchester, England; J. M. Arthur & Company, Chicago, Ill.; Gilman Carriage Works, Worcester, Mass. and the Massachussetts Institute of Technology, Boston, Mass.

The United States Circuit Court of Appeals on the 7th of January rendered a decision in favor of the Chicago Pneumatic Tool Company, in the suit of the American Pneumatic Company against the Boyer hammer, thus confirming the position which the former company has always taken, namely, that the Boyer hammer did not infringe the American Company's patents.

The Missouri Malleable Iron Company, of East St. Louis, Ill., is erecting a number of annealing ovens to give an additional capacity of 5,000 tons per annum to its plant. The company states that this addition was made necessary from the fact that it has secured a number of contracts from railroad companies and car builders and several large contracts from coupler companies.

The Wellman-Seaver Engineering Company, Cleveland, O., have recently furnished two Wellman charging machines for open-hearth furnaces to the Carnegie Steel Company, also one machine for the open-hearth plant of the Buhl Steel Company, Sharon, Pa.; one for the Lukens Iron & Steel Company, Coatesville, Pa., and; one for the Otis Steel Company, Limited, Cleveland, O.

The Bethlehem Iron Company has closed a contract for a hollow-forged tempered steel shaft for the new steamer *Queen City*, of the Pittsburgh and Cincinnati Packet line. The shaft will be 37 feet long 14 inches outside diameter and 7 inches inside diameter. The saving in weight will be about 5,000 pounds even though the strength is greater than would ordinarily be provided in a solid shaft.

The Morton Manufacturing Company, Muskegon, Heights, Mich., have recently received orders for export for one 30-inch stroke shaper to Lobnitz & Company, Renfrew, Scotland; one 36-inch stroke shaper, James & George Tomson, Clydebank, near Glasgow; one 30 inch stroke shaper, Workman, Clark & Company, Belfast, Ireland; one 24-inch stroke shaper with key seating attachment, Adolph Janssens, Paris.

We have received so many excellent calendars for 1897 at this office that we cannot take the space to notice them separately. Most of them are tasteful and neat, none more so than those of the Ashton Valve Company, of Boston; Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio; Vulcan Iron Works, Toledo; Gould Manufacturing Company, Seneca Falls, N. Y., and Rhodes, Gurry & Company, Amherst, N. S.

"Out of the many car builders all over this country," said a prominent export firm, "there are four that actually cater to the export trade. If some of the others would look into the growing export trade it would pay them. Next year's business in this direction will be much more satisfactory than last. Chili, Argentine and Mexico will take double the amount, to say nothing of the far East, etc., etc."—*Railway World.*

The Sargent Company, Chicago, recently shipped to the Pioneer Electric Power Company, Ogden, Utah, a steel flange casting, 6 feet 1¼ inches internal diameter, two flange castings 4 feet 7⅝ inches internal diameter, and one breeches pipe 6 feet internal diameter. The weight of the breeches pipe is 10,000 pounds. The casting is designed to stand a pressure of 200 pounds per square inch, but will safely carry a much higher pressure.

The Robert Aitchison Perforated Metal Company has recently received an order for perforated steel plates for the separating department of a large Eastern iron mine. The order will require almost a carload of steel plates. The fact that this order came entirely unsolicited from the mining company, and without even asking for quotations, is in the highest degree complimentary to the Aitchison Company and indicates the great satisfaction with which previous orders have been filled.

The Niagara Power Company has contracted with the Westinghouse Electric Company, of Pittsburgh, for the construction of five 5,000 horse-power dynamos, identical with those already constructed for and in use by this company. It is said that the order includes two more dynamos conditionally ordered. The Niagara Company has also awarded to William Sellers & Company, of Philadelphia, a contract for five turbine governors and five sluice gates. The turbines will be built by the J. P. Norris Company, of Philadelphia.

The American Road Machine Company, of Kennett Square, Pa., and the Aultman Company of Canton, O., have made an important change in the marketing of their improved road and street machinery, and announce that hereafter the entire output of the two concerns in machinery of this class will be sold by the Good Roads Machinery Company, with headquarters at Kennett Square, Pa. This arrangement, it is believed, will prove beneficial to the manufacturer, dealer and the purchaser, and will enable the Good Roads

Machinery Company to offer a choice to its patrons of the very best machines and tools on the market for road-building and repairing.

The Jeffrey Manufacturing Company, Columbus, O., have recently installed a model coal and ash handling plant in the power-house of the Cicero & Proviso Street Railway Company, Chicago. Ill. Coal is carried in overhead storage bunkers from which it is fed to automatic stokers. The coal is received into chutes from which it is delivered to a conveyor which carries it to a crusher, from which it is spouted to a bucket elevator. This will deliver it either to a conveyor that will take it to a storage bin or to another conveyor, by which it is delivered to the coal bunkers above the stokers. The ash is handled by two 12-inch spiral conveyors from which they are carried by a bucket elevator to an ash tank on the outside of the building.

The Gates Iron Works, of Chicago, have entered the high-speed engine business with the Fischer-Gates single and four-valve self-oiling, automatic engines, built according to the design and under the patents of Mr. Fred F. Fischer. Their product will be handled by Messrs. Fischer & Whiteside, 700-702 Fischer Building, Chicago. Plans for extensive additions to the plant of the Gates Iron Works are completed. The catalogue illustrating and describing the features of the Fischer-Gates engine will be ready for distribution in a short time. Orders for these engines are already on the company's books. The reputation of this concern and that of the gentlemen who are associated with them in this enterprise insures the construction of a first-class engine.

On December 31 the Japanese government signed contracts at Washington for the two cruisers to be built in this country for the Japanese navy, as already stated in these columns. One of the new boats will be built by the Cramps, Philadelphia, and the other by the Union Iron Works, San Francisco. The cruisers will be practically alike and will cost about $1,500,000 each. Their length over all will be 374 feet; breadth, 48 feet; extreme depth, 30 feet, and displacement, 4,760 tons. Their speed will be 22½ knots under forced draft. The main battery will consist of two eight-inch guns, with a secondary battery of ten 12-centimeter guns; twelve 12-pounders, and six 2½-pounders. The boats will have twin screws, the engines will be triple-expansion, and the boilers will be of the cylindrical type.

We have received from the Clayton Air Compressor Works, 26 Cortlandt street, New York, a copy of a newly-issued circular on compressed air shop tools and appliances. The circular illustrates and describes all of the prominent articles of this class now offered for sale in the market, and combined with the company's catalogue No. 8, the field of compressed air machinery is very fully covered. In the circular before us the Boyer, Clement and Keller pneumatic tools or hammers are illustrated and described, also the Phœnix portable rotary drill, Manning portable piston air drill, Phœnix pneumatic breast drill, Pittsburgh bridge riveter, air hoists, Manning sand-papering machine, a pneumatic sand sifter for foundry use, air lift pumping system, a pneumatic rivet holder-on, car seat cleaners, a compressed air engine, wire-wrapped hose, fuel oil burners and self-closing air hose couplings. Those interested in applications of compressed air should send for the circular.

Announcement is made of the organization of a new company to take over the plant and business of the Bucyrus Steam Shovel & Dredge Company, South Milwaukee, Wis. The new company is to be known as The Bucyrus Company. It will continue to make all types and sizes of dredging and excavating machinery for every purpose. For its hydraulic dredges this company builds centrifugal dredging pumps, having simple, compound or triple expansion engines directly connected, up to 1,000 horse-power or more. In addition to its well-known excavating and dredging machinery, the company builds pile drivers, wrecking cars, and placer mining machinery. It is considering the enlargement of its crane department, for the purpose of manufacturing not only locomotive cranes, but also special and power cranes of all descriptions. The officers of the new company are: H. P. Eells, President; A. B. Stetson, Superintendent; A. W. Robinson, Engineer, and J. M. Millman, Secretary and Treasurer.

The Tennessee Centennial Exposition will open May 1 and close Oct. 31 of this year. It is to be held in Nashville and is a celebration by the State of Tennessee of the 100th anniversary of its admission to the Union. It is not intended to run the exposition as a money-making affair and hence it has been possible to eliminate some of the objectionable features of other recent expositions. The commerce building is the largest on the grounds and is 500 by 315 feet with wings 150 feet wide. The agricultural building is 525 by 175 feet the machinery building 375 by 138 feet, the transportation building 400 by 125 feet, and the minerals and forestry building 400 by 125 feet. The size of these structures gives some idea of the magnitude of the coming exposition. There are other buildings, including one by the government, an administration building, woman's building, an auditorium, a children's building, etc., so that the exposition promises to be a complete one and a credit to the State. Mr. J. W. Thomas is President of the exposition; Messrs. V. L. Kirkman, W. A. Henderson, and J. Overton, Vice-Presidents; Mr. Chas. E. Curry, Secretary; Mr. E. C. Lewis, Director General.

Our Directory

OF OFFICIAL CHANGES IN JANUARY.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atchison, Topeka & Santa Fe.—Mr. Geo. A. Hancock has been appointed Assistant Superintendent of Motive Power. James Dunn is Chief Engineer; Mr. C. D. Purden, Assistant Chief Engineer.

Atlantic & Danville.—Mr. Chas. D. Owens, Vice-President and General Manager, died suddenly Jan. 15.

Belt (of Indianapolis.)—President Wm. P. Ijams has resigned, and is succeeded by Mr. D. F. Kinshall.

Chesapeake & Western.—Mr. E. W. Sells has been chosen Vice-President, with office at 30 Broad street, New York.

Chicago, Rock Island & Pacific.—Mr. H. Monkhouse, Assistant Superintendent Motive Power, has resigned.

Chicago & Alton.—Mr. Jacob Johann has resigned the position of Superintendent of Machinery and is succeeded by Mr. H. Monkhouse.

Columbus, Sandusky & Hocking.—Mr. E. M. Poston, of Nelsonville, O., has been appointed Receiver.

Detroit, Grand Rapids & Western.—This is the reorganized Detroit, Leansing & Northern; Mr. Charles M. Heald, President; Mr. E. V. R Thayer, Vice-President; Mr. Charles Merriam, Secretary and Treasury.

Duluth, Missabe & Northern.—Mr. Wm. Smith has been appointed Master Mechanic, vice Mr. A. F. Priest.

East Broad Top.—Mr. F. F. Lyons has been appointed Chief Engineer, with office at Rockhill Furnace, Pa.

Fort Worth & Denver City Railway.—Mr. Morgan Jones, previously General Manager, has been elected Vice-President.

Grand Trunk.—Mr. Frank Joy is appointed Assistant Master Mechanic at Gorham, N. H. Mr. W. D. Robb is appointed Master Mechanic at London, Ont., vice Mr. A. H. Smith, resigned.

Gulf, Colorado & Santa Fe.—Mr. Geo. A. Hancock, Superintendent of Machinery, has resigned.

Hutchison & Southern.—J. A. Graves has been appointed Purchasing Agent, with office at Hutchison, Kan.

Interoceanic Puebla.—Mr. E. W. Knapp has been appointed Master Mechanic.

Lebanon Springs.—Receiver Wm. V. Reynolds died last month.

Long Island.—Mr. H. B. Hodges has been appointed Purchasing Agent and Superintendent of Tests.

Texas Central.—Mr. P. T. Mooney, Master Car Builder, has been appointed Master Mechanic also, at Walnut Springs, Tex., to succeed Mr. F. H. Dehn.

Mexico National.—Master Mechanic E. W. Knapp has resigned.

Missouri, Kansas & Texas Railway System.—Mr. S. B. Fisher is Chief Engineer of the Missouri, Kansas & Texas Railway System, with office at St. Louis, Mo.

Mt. Pleasant & Latrobe.—Mr. H. C. Frick has been elected President.

New England.—Mr. E. D. Robbins, Hartford, has been chosen Vice-President.

New York, New Haven & Hartford.—The position of Third Vice-President has been abolished.

Oregon Short Line & Utah Northern.—Mr. W. H. Bancroft has been elected General Manager.

San Antonio & Gulf Shore.—Mr. George Dullnig has been appointed Receiver, vice Mr. H. Terrall.

St. Louis, Cape Girardeau & Fort Smith.—General Manager E. S. McCarty has resigned.

St. Clair, Madison & St. Louis Belt.—Mr. J. F. Barnard has been appointed Receiver.

Toronto, Hamilton & Buffalo.—Vice President J. N. Beckley has been elected President.

Wheeling & Lake Erie.—Mr. M. T. Herrick, of Cleveland, and Mr. Robert Blickensderfer, Toledo, have been appointed Receivers.

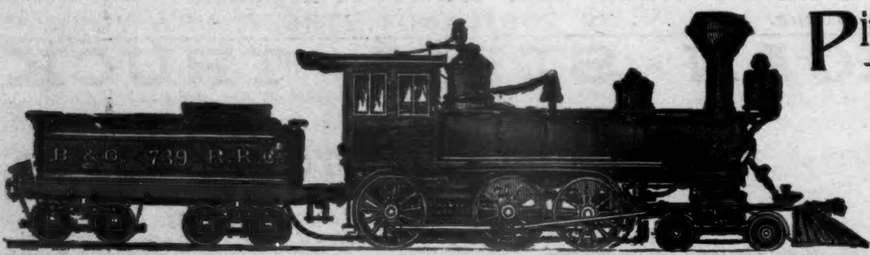
Youghiogheny Northern.—Mr. H. C. Frick has been elected President.

THOMAS PROSSER & SON,
15 GOLD STREET,
NEW YORK.
Old Colony Building, Chicago.

KRUPP STEEL TIRES

On Locomotive Driving Wheels and on Steel-Tired Wheels

GIVE THE BEST RESULTS - - - FOR EVERY VARIETY OF SERVICE.



Pittsburgh Locomotive and Car Works,

PITTSBURGH, PA.

Manufacturers of - - **LOCOMOTIVE ENGINES for Broad or Narrow Gauge Roads**

From standard designs, or according to specifications, to suit purchasers. - -

Tanks, Locomotive or Stationary Boilers Furnished at Short Notice.

Wilson Miller, Prest. & Treas.
D. A. Wightman, Supt.

CATECHISM OF THE LOCOMOTIVE

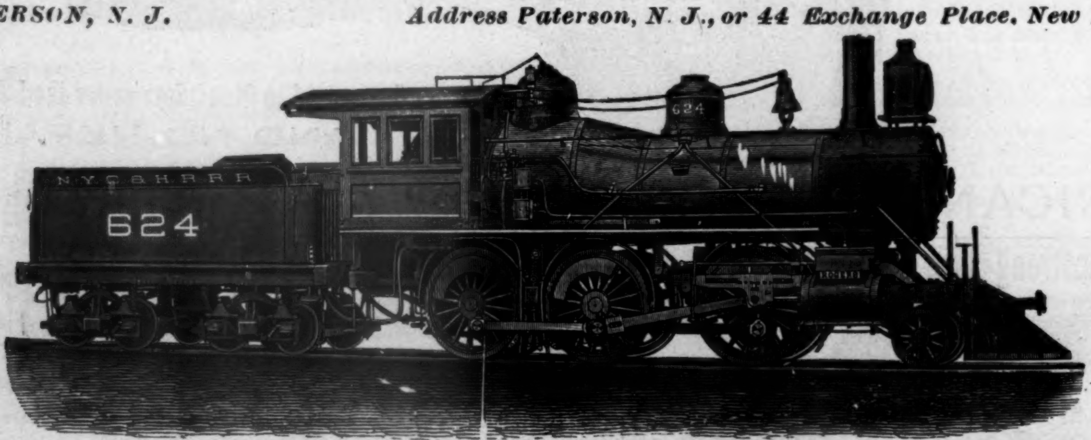
For seventeen years it has been the best authority and almost a necessity to every Locomotive Engineer and Fireman, and on many railroads it is the standard for examination of Fireman for promotion. **PRICE $3.50.**

FOR SALE BY : :

American Engineer, Car Builder and Railroad Journal, Morse Building, N. Y. City.

ROGERS LOCOMOTIVE COMPANY

PATERSON, N. J. ***Address Paterson, N. J., or 44 Exchange Place, New York.***



BUILDERS OF LOCOMOTIVE ENGINES AND TENDERS OF EVERY DESCRIPTION

R. S. HUGHES, President. G. S. LONGBOTTOM, Sec'y. G. E. HANNAH, Treas. REUBEN WELLS, Supt.

SCHENECTADY Locomotive • Works,

SCHENECTADY, N. Y.

ESTABLISHED 1848.

Annual Capacity, 450.

EDWARD ELLIS, President.
WM. D. ELLIS, Vice-Pres. and Treasurer.
A. J. PITKIN, Superintendent.
A. P. STRONG, Secretary.